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DISEASES OF THE BLADDER PROSTATE GLAND, AND URETHRA.

By the Same Author.

THE SCIENCE AND PRACTICE OF SURGERY.

Illustrated by 969 Wood Engravings, chiefly new and original. Pp. 1714.
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A GUIDE TO THE EXAMINATIONS AT THE ROYAL COLLEGE OF SURGEONS OF ENGLAND FOR THE DIPLOMAS OF MEMBER AND FELLOW.

Fourth Edition, Revised and much Enlarged, fcap. 8vo., 4s. 6d.

DISEASES OF THE BLADDER PROSTATE GLAND, AND URETHRA.

INCLUDING A

PRACTICAL VIEW OF URINARY DISEASES DEPOSITS AND CALCULI.

ILLUSTRATED BY NUMEROUS WOOD ENGRAVINGS.

Fifth Edition,

REVISED AND MUCH ENLARGED THROUGHOUT.

BY

FREDERICK JAMES GANT, F.R.C.S.,

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PREFACE TO THE FIFTH EDITION.

SINCE the publication of the previous edition of this treatise, the progress of Surgery, in the department to which it relates, has been such as to have partly changed the former state of knowledge, and to have notably advanced the frontier of past experience. In preparing a new edition scarcely a page has been left without some important revision, or fresh resources—clinical, manipulative, or operative; and the concluding chapter, on Urinary Diseases, Deposits and Calculi, has not been overlooked in the general renovation which the whole subject has undergone.

Moreover, the exceptional circumstances in which the Surgeon may be placed have been entered into, as well as the more common course of practice—with regard to Diseases of the Bladder, Prostate Gland, and Urethra. The felt difficulties of diagnosis have thus led me to consider the differential characters of some diseases which are seemingly alike, and to notice also the variations of the same disease in its course and terminations. Then, again, all those questions relating to treatment, wherein the Surgeon is called upon to form a sound judgment with regard to operations under different pathological conditions, have received particular attention; as, in thereby determining the selection of alternative operations, or the adaptation of methods to circumstances, and in encountering the difficulties and accidents which may be met with during operative procedures.

In handling a subject, which if complex need not be complicated, I have aimed at simplicity; seeking to exhibit that virtue even in the choice of instruments, from the mystifying multiplicity with which the armamentaria for the treatment of Diseases affecting the Urinary Organs has been overstocked—whether in the form of some new instrument by one inventor, or as "modified" by another.

The Surgical Anatomy of the Bladder, Prostate Gland, and Urethra, has been revised from careful dissections which I made at the Royal College of Surgeons; Professor Flower having kindly given me the opportunities requisite for this purpose. It supplies an appropriate introduction to the various methods of examination, and the numerous operative procedures pertaining to those organs, under all the conditions and circumstances of disease and injury which are developed in the subsequent chapters.

The additional matter now introduced into this treatise —to the amount of one hundred and forty-four pages— will render it a more complete exposition of the Diseases relating to the Urinary Organs, and, perhaps, than has hitherto been published in this country. No other work on this branch of Surgery, so far as I know, covers the same ground.

As a practical view of a large and difficult class of diseases commonly met with, and often urgent, it will, I trust, be found a clear and reliable, and withal a ready guide, to their clinical investigation, their diagnosis, and their treatment. While narrating what has been seen and done in a field of inquiry, where many fellow-labourers, past and present, have worked so long and so well, the descriptions and directions I have given, perhaps with much detail, possess, at least, the freshness and the advantage of having been amply verified by my own course of experience.

FREDERICK JAMES GANT.

16, CONNAUGHT SQUARE,
LONDON, W.
November, 1883.

*** The lay reader, in general, of a medical work—especially on the subject of this treatise—is very liable to misunderstand the descriptive portraitures of disease; and by applying a single symptom, or symptoms unconnected, to himself, he is often led to misinterpret the nature of a disease from which he may be suffering—or even to imagine himself the subject of some complaint, which is simply the product of his own misconception. The author having seen—and quite recently—so much deplorable error and misery resulting to patients from their studying Diseases of the Urinary Organs, he has written this treatise in a purely technical form, for the guidance of the profession only; and thus to render the whole as unintelligible as possible to the public. The majority of the latter class would, indeed, be better able to walk barefooted to Jerusalem, than to rightly comprehend the greater portion of the text. For the reasons referred to, the personal histories of cases, more especially, respecting the diseases under consideration, have been purposely omitted.

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DISEASES OF THE BLADDER, PROSTATE GLAND, AND URETHRA.

INTRODUCTION.

He who would gain a clear appreciation of the various diseased conditions to which the Urinary Bladder, Prostate Gland, and Urethra are severally liable, and of their appropriate surgical treatment, must first acquire an accurate anatomical knowledge of these organs, with regard to their structure, size, shape, position, relations, and surrounding connections, as described from a *Surgical* point of view. To the practitioner such an introduction to the subject may at least prove serviceable for reference to that anatomical knowledge which he must carry with him in the practice of this department of Surgery.

Urinary Bladder.—*Structure.*—The bladder is a musculo-membranous bag or sac, and is richly endowed with blood-vessels, lymphatics, and nerves — sympathetic and spinal. Situated in the pelvic cavity, but during childhood partly in the abdomen, it is placed behind the pubes and triangular ligament, in front of the rectum, or of the uterus and vagina, which in the female separate the bladder from the bowel. This hollow organ communicates with the ureters and the urethra; its physiological function being that of a reservoir for the urine, which, as secreted by the kidneys, is received through the ureters and retained, until from time to time convenience may permit of the voluntary discharge of that fluid through the urethral canal.

I proceed to a more detailed description of the bladder and its relations, as thus defined. The structure of this organ elucidates the different functional disorders to which it is so often liable: *e.g.*, Irritability, with frequent and painfully urgent Micturition, Neuralgia, Paralysis, Retention, etc.

The bladder may be regarded as essentially a hollow expansion of *mucous membrane* continuous with that of the ureters behind and the urethra in front; the external surface of this sac is overlaid with bands of *muscular fibres,* the unstriped and involuntary variety, disposed in figure-of-8 spiral loops, vertically, obliquely, and horizontally;* springing, for the most part, from the neck of the bladder, to be presently noticed, these muscular bands are thus entwined over and around the organ, leaving intervals of mucous membrane uncovered; a layer of *cellular tissue* intervenes between the two, this submucous texture containing an abundance of the finely coiled fibres of elastic tissue. The muscular arrangement forms the "detrusor urinæ" muscle, and a marked band around the neck of the bladder is named "sphincter vesicæ." The action of these muscles is involuntary in expelling or retaining the urine; but in the function of micturition, the sphincter of the bladder is voluntarily relaxed, the detrusor then expelling the urine, aided by the compressive action of the abdominal muscles as a voluntary effort. *Blood-vessels* are plentifully supplied to the bladder, and have the following distribution. The internal iliac artery, from its anterior division, gives off the *superior* and *inferior vesical* branches, and in the female the *uterine* arteries also, all of which ramify and terminate in the cellular texture and mucous membrane; the *veins* form large *plexuses,* situated chiefly at the neck, sides, and base of the bladder, and, terminating in the internal iliac veins, are accompanied in their course by *lymphatic vessels,* which enter lymphatic glands around the internal iliac artery, and thence proceed upwards to the lumbar glands. *Nerves* are supplied in equal abundance. They proceed partly from the fourth nerve, or sometimes the third nerve of the *sacral plexus,* itself derived from the spinal cord, and these *spinal* nerves are distributed to the base and neck of the bladder; but the *hypogastric plexus* from the great *sympathetic* cords—a plexus situated between the common iliac arteries—supplies two large prolongations which descend into the pelvis, one on either side, to form two lateral pelvic plexuses, which communicate with a few offsets from the first or two first ganglia in the sacral cord of the sympathetic; and these pelvic plexuses, expanding over the sides of the bladder and rectum, or vagina, are distributed to the upper portion and remaining part of the organ, not supplied from the sacral plexus. Both sets of nerves—spinal and sympathetic—*communicate* in the pelvic plexuses; and the sacral nerves, third and fourth, on either side, contribute branches thereto, aided by a filament or two from the second sacral nerve. Many ganglia are interspersed in each plexus, thus constituted, particularly at the junctions of the spinal and sympathetic nerves. The filaments from either plexus pass along and accompany the branches of the internal iliac artery, given off to the bladder, as already mentioned. The muscular bands, blood-vessels, lymphatics, nerves, and cellular texture, together form a second coat, overlaying the "mucous coat;" while, externally, this "muscular coat" is partially invested with the peritoneum, forming the "peritoneal or serous coat," which, however, extends over only the posterior half of the bladder, being reflected so as to leave the anterior half of the organ uncovered, or free of this investment.

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* Original Dissections by J. Bell Pettigrew, Museum Roy. Coll. of Surgeons, Eng., and, same authority, "On the Muscular Arrangements of the Bladder and Urethra," etc., "Phil. Trans.," 1867.

Ligamentous Connections.—The *peritoneum* covering the front of the rectum—or uterus, in the female—is reflected backwards over the posterior part of the under surface or base of the bladder, forming the *recto-vesical* pouch or *cul-de-sac*, in that situation; thence curving upwards and forwards over the posterior surface and adjoining part of each side of the bladder to gain the summit, it is again reflected to either side of the pelvis; and lastly, from opposite the back of the pubes to the wall of the abdomen. These peritoneal reflexions are named *false ligaments* of the bladder, and are *five* in number: the portions of peritoneum extending from the back of the pelvis to the bladder, and which bound the recto-vesical pouch, form two *posterior* false ligaments; the lateral reflexions, extending from the sides of the bladder to the pelvis, form two *lateral* false ligaments; and the superior reflexion gives rise to the *superior* or *suspensory* false ligament. But all these so-called ligaments represent one continued reflexion of the peritoneum, as conducted apparently by the course of the internal iliac arteries, and their continuation, the obliterated hypogastric arteries in the adult. Guided by these vessels, and, it may be said, by the ureters, the peritoneum passes forwards along the sides of the middle portion of the rectum to the under surface of the bladder, thence up its sides to the summit, and so to the abdominal wall. In the latter situation, the obliterated *urachus*, a fibro-cellular cord passes from the top of the bladder, in the interval between the two hypogastrics; and with them reflecting the peritoneum upwards, these three cords ascend along the linea alba to the umbilicus. The *true* ligaments of the bladder are prostatic portions of the recto-vesical fascia, on either side of the pelvis; *four* such portions of this fascia, or ligaments, being recognised—two anterior, in front of the prostate, and two lateral, at the sides of that body. Their derivation from the recto-vesical fascia, and their attachments as ligaments of the bladder, may be traced from the *pelvic fascia.* This fascia descends from the brim of the pelvis, and covering the upper part of the obturator internus muscle, as far as a white line extending between the body of the pubes and the spine of the ischium, the fascial origin of the levator ani muscle, the fascia there splits into two layers; one layer being continued downwards over the lower part of the obturator muscle, is thence named the *obturator fascia*); the other layer, inclining inwards and downwards from the white line, passes as a broad expansion, over the upper surface of the levator ani muscle, to the side of the rectum, bladder, and prostate, thus acquiring the name of the *recto-vesical* fascia. This visceral layer of the pelvic fascia assumes ligamentous connections in the middle line. Attached to the back of the body of the pubes, just internal to the pubic origin of the levator ani muscle, the fascia, on either side of the pelvis, passes backwards, in front of the prostate to the neck, and adjoining part of the bladder, in the shape of two roundish, strong, white bands, a right and a left, forming two *anterior* true ligaments; while another portion of the fascia, broader and thinner, passing back on the side of the prostate, to the neck and side of the bladder, forms two *lateral* true ligaments. The anterior true ligaments, therefore, are better defined; and between the two is a cellular interval, in which lies the dorsal vein of the penis, or clitoris in the female. These bands of the fascia cover in the anterior fibres of the levator ani—the levatores prostatæ, which are spread over the prostate, here closing the outlet of the pelvis; a continuation from the lateral bands completely ensheathes the prostate, as a *capsule*, an offset of which passing backwards encases the vesiculæ seminales; and the rectal portion of the fascia, from either side, passes inwards between the bladder and bowel, ensheathing the rectum and supporting the bladder; but in its prolongations upwards on these viscera the fascia gradually becomes mere cellular membrane, and is lost in the thin pelvic fascia over the front of the sacrum and pyriform muscle, where the vessels and nerves perforate it to reach the bladder.

The *outlet* of the *pelvis* is closed in by the recto-vesical fasciæ of opposite sides, which, like the levatores ani muscles, form a partition, concave above, convex below; this, however, is perforated by the rectum and prostate, both of which derive sheaths from the membrane in their passage through it. In the *female*, the recto-vesical fascia has the same arrangement, except that besides the rectum, the vagina, instead of the prostate, perforates and is ensheathed by it. By means of the ensheathing prolongations of this membrane, and the corresponding attachments of the subjacent levatores ani muscles, the pelvic viscera are slung in the cavity of the pelvis, with an easy mobility upwards and downwards; as the musculo-membranous floor rises, or descends, these viscera are drawn upwards, or tend to protrude towards the outlet of the pelvis in the perineum.

The *relations* of the bladder to surrounding parts are surgically very important (Fig. 1).

The *anterior* surface of the bladder, entirely free of peritoneum, is situated behind the body and symphysis of the pubes, and the triangular ligament in the pubic arch. This latter relation of the bladder corresponds to the anterior half of the perineum, in front of the anus; or, in the female, to that smaller part of the vulva which extends between the clitoris and the orifice of the urethra. Above the pubes, the bladder, when distended, rises to the lower part of the abdominal wall.

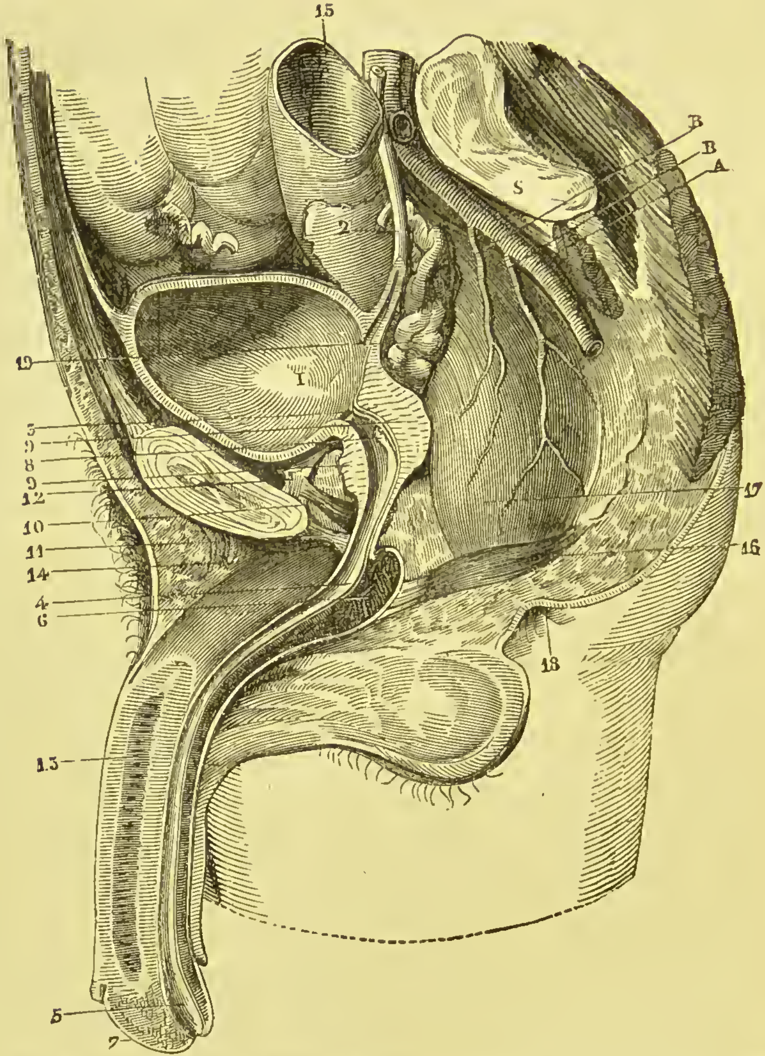

FIG. 1.—Side view of pelvis, in Male—1. Bladder. 2. Ureter. 3. Neck of bladder. 4, 5. Urethra. 4. Cul-de-sac of bulb. 5. Fossa navicularis. 6. Bulb. 7. Glans penis. 8. Veru montanum, or caput gallinaginis. 9, 9. Prostate. 10. Wilson's muscle. 12. Pubo-vesical ligament. (The last two are not recognised now.) 11. Triangular ligament of urethra. 13. Corpus cavernosum. 14. Suspensory ligament of penis. 15. Rectum. 16. Sphincter ani. 17. External longitudinal muscular fibres of rectum. 18. Anus. 19. Seminal vesicle. A. Internal iliac artery. B, B. Middle hæmorrhoidal arteries. S. Sacrum. (After Blandin.)

At the lowest part of the anterior surface of the bladder, a narrow funnel-shaped portion, named the *cervix* or *neck,* is surrounded by the prostate gland, a body about the size and shape of a horse-chestnut, which transmits the first or prostatic portion of the urethral canal; and the prostate, thus standing in front of this part of the bladder, intervenes between this organ and the lower part of the triangular ligament (Fig. 1).

The *base* or *inferior fundus,* the largest and most dependent portion of the bladder, is directed downwards, and inclined backwards according to the degree of distension; it rests upon the rectum, its second portion, the vesiculæ seminales and vasa deferentia intervening, and further back, the recto-vesical pouch of the peritoneum. This *cul-de-sac,* broad behind in the interval between the iliac arteries on either side of the rectum, narrows forwards, and is tucked, as it were, under the bladder. In front is a triangular space, where the base of the bladder lies free of peritoneum, and attached to the rectum by the recto-vesical fasciæ; the apex of this space touches the prostate, its base behind is limited by the peritoneal pouch, and the sides are bounded by the vasa deferentia, and the seminal vesicles outside these tubes, as both converge forwards to enter the prostate gland (Fig. 1). Usually, the *recto-vesical pouch* of peritoneum extends forwards to a point corresponding to about *one inch and a half* from the tip of the coccyx, or about *four inches* distant from the anus; sometimes, however, the pouch reaches forwards to the prostate, leaving no triangular space uncovered at the base of the bladder.

In the *female*, the base of the bladder rests upon the anterior wall of the vagina, and further back on the lower part of the uterus, these organs being placed between the bladder and rectum (Fig. 2). The *utero-vesical* pouch of peritoneum extends forwards only as far as between the *uterus* and bladder, leaving the cervical aspect of the uterus and the vagina uncovered and adherent to the bladder at the fore part of its base.

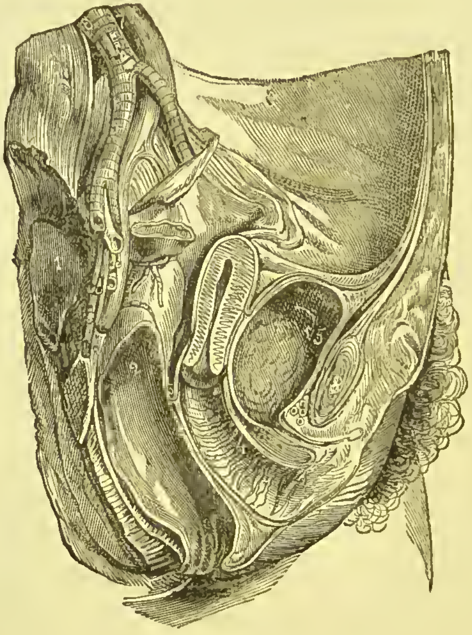

FIG. 2.

The *posterior* surface of the bladder is in contact with the rectum (Fig. 1), or, in the *female*, with the uterus (Fig. 2); but this surface of the bladder is covered entirely by the peritoneum, reflected upwards from the rectal, or uterine, *cul-de-sac*.

The *sides* of the bladder are each crossed obliquely from behind by the cord of the obliterated hypogastric artery, passing forwards and upwards to the summit of the organ. Behind and above this cord, the peritoneal investment of the posterior surface is prolonged forwards over the sides of the bladder; but in front of the cord, which reflects the peritoneum, the sides are uncovered, being, however, here supported by an expansion of the recto-vesical fascia. This otherwise uncovered portion of the bladder, on either side, is in immediate relation to the *ureter* which transmits the urine from the kidneys into the bladder, and the *vas deferens* or excretory duct of the testis. The ureter, a tube like a white band, having descended into the pelvis across the common or the external iliac artery, it curves downwards, forwards, and inwards in the posterior vesical ligament, arching *below* the obliterated hypogastric artery, to gain the lateral aspect of the base of the bladder (Fig. 1), which it enters about two inches and a half from the prostate gland, and rather less than that distance from the ureter on the opposite side; the tubes penetrate the coats of the bladder obliquely for nearly an inch, passing through the muscular coat and then between it and the mucous coat, to open upon the inner surface of the bladder by two oblique slit-like apertures. The vas deferens, a small round cord-tube, one on each side, having entered the abdomen through the internal abdominal ring, this cord curves backwards and downwards on the side of the bladder, to near its posterior surface; then crossing the hypogastric artery and the ureter on the *inner* side of that tube, the cord turns forwards along the base of the bladder (Fig. 1), lying to the inner side of the seminal vesicle, where, becoming enlarged and sacculated, the vas deferens enters the base of the prostate gland, there joining with the duct of the seminal vesicle to form the common ejaculatory duct. The *vesiculæ seminales* (Fig. 1), one on each side, are narrow, club-shaped, sacculated bodies, the large end being directed backwards, and extending to about two and a half inches in length. Consisting of a convoluted tube, encased in an offset of the prostatic portion of the recto-vesical fascia, each vesicle lies on the outer side of the vas deferens, and converges from behind forwards to the prostate.

In the *female,* the ureters pass along the sides of the cervix uteri and upper part of the vagina to reach the bladder; and the vasa deferentia, vesiculæ seminales, and prostate gland are absent.

The *summit* or *superior fundus* of the bladder, covered behind by peritoneum, is free in front, where that membrane is reflected upwards to the abdominal wall by the three cords already mentioned, namely, the two obliterated hypogastric arteries, and the urachus in an interval between them; this anterior and uncovered portion of the summit looks towards the abdominal wall above the pubes (Fig. 1). Convolutions of the small intestine rest upon the top of the bladder, and sink down behind its posterior surface into the peritoneal pouch, —recto-vesical, or utero-vesical, *cul-de-sac.*

Internal Surface of the Bladder.—The inner surface of the *mucous coat* of the bladder presents certain characters worthy of notice, and some peculiarities which mark the interior.

The mucous membrane is soft, and smooth, and of a pale rose-colour; it is studded with minute follicles, most numerous near the neck of the bladder, and the whole surface is covered with a spheroidal epithelium. The vesical mucus has, it is said, an alkaline reaction, and contains alkaline and earthy phosphates. The membrane—having these characters—is loosely attached to the muscular coat, by means of the sub-cellular layer; so that when the bladder is empty, the surface generally is thrown into small internal folds or wrinkles, and when distended, there is some tendency to protrusion in the intervals of the muscular bands.

The *inferior fundus* is the most capacious and dependent part of the bladder; in front, it presents a small triangular space—the *trigone vesical;* situated immediately behind the orifice of the urethra, the apex of this space is directed forwards to that orifice, and the base is a transverse line slightly curved forwards, between the orifices of·the two ureters, which form the posterior angles of the space; while the sides are marked by two linear ridges passing obliquely backwards and outwards from the urethra to the ureters, and which correspond to two small fasciculi of muscular fibres—the muscles of the ureters, lying under the mucous membrane. These muscles arise from behind the middle lobe of the prostate, and pass to the oblique slit-like openings of the ureters; they may, therefore, so act upon these openings as to maintain their obliquity, and thus prevent any reflux of urine into the tubes; or, by drawing their apertures downwards, may facilitate the flow of urine into the bladder. The trigone—having the boundaries already noticed—corresponds to the triangular space at the *base* of the bladder, which lies between the prostate in front, and the peritoneal pouch behind, bounded laterally by the vasa deferentia and vesiculæ seminales; but the triangular space within the bladder is of even more limited extent, measuring from the apex backwards about one inch and a half, and between the two posterior angles—at the orifices of the ureters—from that to two inches transversely. The surface of this space is smooth, the mucous membrane being somewhat thinner than elsewhere, and adherent to the subjacent texture; thus never presenting any little folds, even in an empty state of the bladder. But this area in the inferior fundus is the most sensitive portion of the whole interior. In front of the apex of the trigone, a small transverse prominence appears—the *uvula vesicæ*—formed by a thickening of the submucous tissue; this elevation is placed just before the middle lobe of the prostate, and projecting from below into the urethral orifice, it partly closes the aperture; and is sometimes continued forwards as a slighter elevation on the floor of the prostatic portion of the urethra. Adjoining the orifice of the urethra, the bladder becomes narrowed into a funnel-shaped portion—the *cervix* or *neck*—within which the mucous membrane is disposed in longitudinal folds. In the *female* the trigone is a smaller space, the muscles of the ureters are less developed, and the uvula is indistinct.

Size, Shape, Position, and Relations of the Bladder, as altered by the State of Distension.—The surgical anatomy of the bladder varies in certain important particulars, according to the state of collapse or distension of this organ—conditions which specially have practical application to operations for the relief of retention of urine, and are also concerned in the various operations of lithotomy and lithotrity. When entirely *empty,* after the complete evacuation of urine, it is reduced to its minimum size, and it then has the shape of a triangular sac, flattened in front and behind; its base is directed downwards, resting on the rectum, and the apex reaches upwards to behind the symphysis pubis, so that the sac lies against the triangular ligament, and sunk down entirely within the cavity of the pelvis. When *moderately* distended—as was supposed in describing the relations of the bladder—this sac assumes a circular form, with the corresponding dimensions of about three inches in width and five inches in length, the organ holding about a pint; but its axis remains nearly vertical, and it is still contained within the pelvic cavity. When *fully* distended, the bladder acquires an ovoidal or egg-shaped form, curved also somewhat, and compressed, from behind forwards, thus becoming slightly concave in front and widened from side to side; the organ has rotated on its transverse axis, the base being directed downwards and backwards on the rectum, or vagina, and the summit looking upwards and forwards—its long axis, therefore, inclining in an oblique line drawn from the coccyx to some point between the pubes and the umbilicus; the bladder rises in the direction of this line, out of the pelvis, until its summit touches the wall of the abdomen above the pubes, in the hypogastric region, at a height varying according to the state of distension. This elevation of the bladder proceeds from the neck, which, owing to its true ligamentous attachments, and connection with the urethra, is a tolerably fixed point. The funnel-shaped outlet still remains the lowest portion in front, but it is elevated relatively to the prostate; the inferior fundus, also rising to a higher level, is relatively less dependent; while externally, the peritoneal pouch recedes to some extent from the base, thus presenting a larger triangular space against the rectum, and the summit of the bladder, in front of the superior peritoneal false ligament, is more exposed, or comes in contact with the wall of the abdomen above the pubes.

The *age* of the subject examined must not be overlooked in noticing the relative anatomy of the bladder.

In *infancy* and *youth*, the neck is the lowest portion of the bladder,—lower than the inferior fundus; the prostate, in front, around this portion, is of much smaller size or rudimentary; and the bladder lies partly in the cavity of the pelvis, but projecting upwards more or less above the brim into the hypogastric region.

In *old age*, on the other hand, the inferior fundus is even more capacious and dependent than in the adult, and any enlargement of the prostate will increase this proportionate difference; so that if the finger be introduced through the neck of the bladder, as in lithotomy, the fundus is felt inclining downwards, and as the prostate projects upwards, the finger must be hooked downwards to reach the fundus.

In the *female*, the prostate being absent, the inferior fundus is less relatively dependent below the neck of the bladder, but the capacity of the whole organ is perhaps larger than in the male; and its width from side to side is greater than its height from base to summit, which is the longer diameter in the male subject.

Prostate Gland.—By an intimate association, both pathological and surgical, we are led from the anatomy of the bladder to consider the structure and relations of the prostate gland. We proceed therefore to notice, successively, the situation, shape, size, position, and relations of this organ; then, its structure; and lastly, the prostatic portion of the urethra. The surgical examination, diagnosis, and operative treatment of prostatic enlargement, and of other diseases of the organ, will be guided by this anatomical knowledge; and which also has most important applications in the operations of lithotomy and lithotrity.

The prostate, an organ peculiar to the male subject, is a firm glandular body, *situated* at the neck of the bladder, which it surrounds, and the commencement of the urethra passes through it (see Fig. 1). This body is placed deep in the cavity of the pelvis, and looking towards its outlet in the perineum; it lies below the symphysis pubis by half an inch or more, and behind the triangular ligament at its lowest part; standing in front of the neck of the bladder, adjoining its base, the prostate thence derives its name (*προΐστημι*, to stand before); and beneath it rests on the middle portion of the rectum, just above the terminal portion,—about the depth of one inch and a half from the anus, where the bowel turns downwards to the anal aperture. Here, therefore, the prostate is accessible from the surface in the perineum.

The shape and size of this body resemble the form and dimensions of a horse-chestnut. Its *shape* is that of a truncated cone, compressed from above downwards; the base being turned backwards to the bladder, and the blunt apex forwards to the triangular ligament and the membranous portion of the urethra. The anterior, or upper, surface—according to the position of the body—is somewhat convex, and marked by a slight median groove; the under surface is larger and flattened, it also presents a median furrow, thus indicating a division of the gland into two lateral lobes. The base of the prostate, its thickest part, is notched in the middle and under aspect of the gland; and this posterior notch receives the common ejaculatory ducts, above which, and in the interval between the lateral lobes, is placed a small rounded or triangular portion of the gland—the third or middle lobe, transversely connecting the two lateral lobes, and which lies beneath the neck of the bladder, just behind the uvula and the adjoining commencement of the urethra. The sides of the prostate are convex, and the apex is truncated. In respect to the *size* of this body, it varies so much according to the age of the subject, that the average dimensions must be taken as found in the adult. The measurements in three different directions may thus be stated: from apex to base, one inch or rather longer; transversely at the base, its widest part, about one inch and a half; and in depth or thickness, about one inch or rather less. Consequently, an incision having an oblique direction downwards and outwards, from apex to base, in the lateral part of the gland, will be the longest section of which the prostate admits. But in infancy and youth, the gland is rudimentary or of small size, whereas, after middle-life and in old age, it may undergo considerable enlargement. The weight of this body averages from half an ounce to an ounce; but this, like its size, varies with the period of life, and in different individuals of the same age.

The *position* of the prostate, or its attitude, must necessarily change, with the position of the pelvis—in the recumbent or the erect state of the body. When recumbent, the pelvis has that position in which a line drawn through the prostate, from apex to base, would be directed obliquely downwards and backwards; the upper surface inclining backwards, and the lower surface somewhat forwards, the more so as the pelvis is elevated; and this corresponds with the position in which the prostate is generally submitted to surgical examination, or operation, in connection with the bladder. In the erect state of the body, the axial line of the prostate falls from the oblique to nearly a horizontal direction; and when the trunk is inclined forwards, so as to present the fundament backwards, the prostate, its under surface, turns with it in the latter direction—thus corresponding to the position in which the gland may be examined with the finger through the rectum.

Certain *relations* of the prostate to surrounding parts have already been noticed incidentally, with reference to the neck of the bladder, the pelvic cavity, and the rectum. Thus, the base of the gland, around the neck of the bladder, receives also the common ejaculatory ducts, and it limits in front the triangular space which is free of peritoneum at the base of the bladder; the apex of the gland touches the triangular ligament and the membranous portion of the urethra, in the pubic arch, about half an inch below the pubes; and its under surface rests upon, and is closely adherent to, the rectum, just above its terminal portion, which turns downwards to the anus. This under surface of the prostate, and its base, may be felt by introducing the finger through the anus into the bowel. The remaining surfaces have special relations to the recto-vesical fascia. Thus, the upper surface of the prostate, below the pubic symphysis, is covered by the two strong, roundish bands, which form the anterior true ligaments of the bladder, with the dorsal vein of the penis lying between them; while the sides of the gland are covered by the broad and membranous lateral true ligaments of the bladder.

But in addition to these fascial prolongations, thus disposed, the remainder of the prostate receives an investment from the same fascia; forming altogether a complete sheath or capsule which envelops the gland. External to this capsule, the sides of the prostate are overlaid by the anterior fibres of the levatores ani muscles, one on each side; which, passing down from the symphysis pubis, and spreading over the sides of the gland, unite together in front of the rectum, in the central tendinous point of the perineum with the fibres of the external sphincter of the anus. Thus the prostate is slung by the levatores ani muscles, just as the rectum, and the vagina in the female, are also slung by these muscles; and these anterior portions of the muscular fibres, which are sometimes defined by a cellular interval, have been named *levatores prostatæ*. In old persons, the rectum may have become much dilated above the anus, forming a pouch, which rises up and wraps around either side of the prostate, so as to enclose this body, except at its upper surface.

The *structure* of the prostate gland was so far noticed in describing the shape of this organ, that it was seen to consist of three lobes; two lateral, of equal size, separated only by a median furrow on the upper and lower surfaces of the gland, and by a notch at the base; within which interval is placed the middle or third lobe. The mass of the gland, having this lobed arrangement, is encapsuled within a fibrous coat, consisting of two layers; an external dense layer, or an ensheathing prolongation from the recto-vesical fascia, as already mentioned; and an inner, thin, membranous investment, which sends processes into the interior of the gland, supporting its substance. Between these two layers of the *capsule,* a *plexus of veins,* the prostatic plexus, is enclosed. The substance of the gland has a reddish or brownish colour; its texture is spongy or firm to the touch, although not so dense as when felt through the fibrous coat, with perhaps also the thickness of the rectum intervening; and it yields or lacerates under pressure with the finger—splitting in the direction of its grain, the prostatic ducts, as when, in the operation of lithotomy, the prostatic incision is enlarged by introducing the finger into the bladder. The glandular substance consists of numerous small terminal follicles, which, in the form of clusters, surround and open into the elementary ducts; these, having a branched arrangement, unite into the excretory ducts, about twelve to twenty in number, which open by as many orifices upon the floor of the prostatic portion of the urethra. The epithelium in the follicular terminations is squamous, and in the ducts, columnar. Section of the gland shows the ducts, which appear as white lines or minute apertures, according to the direction of their division. Richly supplied with blood-vessels, the arteries are branches of the vesical, hæmorrhoidal, and pudic arteries, which passing into the substance of the gland ramify and form a capillary network around the ducts and clusters of follicles; the prostatic veins form a plexus around the gland, between the two layers of its fibrous capsule, and this venous plexus communicates in front with the dorsal vein of the penis, but behind with the plexus of veins at the neck, base and sides of the bladder, thence passing into the internal iliac veins. This continuous plexus of veins—prostatic and vesical—becomes enlarged in old subjects, and is often the source of troublesome hæmorrhage when wounded in lithotomy. Lymphatic vessels, with the veins, ramify beneath the dense external layer of the fibrous capsule. Nerves are derived from the pelvic hypogastric plexuses on either side of the bladder, prolongations from which form the *prostatic plexus of nerves.*

The *prostatic fluid,* or secretion of the gland, mixed with the seminal fluid, is discharged in the act of emission. But the nature of this fluid in itself is not well known. After death, when fresh, it has a milky white tint, an acid reaction, and abounds with granular matter and epithelial particles, squamous and columnar.

URETHRA.—The urethra is a membranous tube, which extends from the neck of the bladder to the end of the penis. Accurate anatomical knowledge of this passage—

in regard to its structure, length, diameter, direction, and relations—will necessarily guide the surgeon in the various operations for the treatment of stricture, and of other urethral diseases. The *length* of this tube averages nine or ten inches, when the penis is flaccid, but admits of some elongation during erection of this organ; the *diameter* of the tube varies in different parts, being about a quarter of an inch at its widest part—the centre of the prostate. The urethral tube *consists* of mucous membrane, with an outer or sub-mucous layer of involuntary muscular fibres, in cellular and elastic tissue; but the tube is supported also by the structures through which it passes, and by certain muscular expansions. Lying in the middle line, the urethra passes from the bladder through the substance of the prostate gland; then, becoming simply membranous, the tube penetrates the triangular ligament, under the arch of the pubes; where, entering the spongy structure of the penis, it is continued to the end of the glans and opens externally as the *meatus urinarius.* The *direction* of the urethral canal, in its course forwards, is that of a double curve (see Fig. 1); the prostatic and membranous portions, and the commencement of the spongy portion, or its bulbous part, together form a curve, downwards, forwards, and upwards to the front of the pubes; from which point, the remainder of the spongy portion descends in the penis. This double curve, however, depends upon the state of the penis; for when this organ is erect, or raised upwards towards the pubes, the second curve forms with the first, a single curve, thus continuing the concavity of the curve upwards,—as in passing a catheter.

The urethra performs the excretory function of transmitting and discharging the urine from the bladder; but it also transmits the seminal fluid in sexual intercourse.

The three portions of the urethra, already indicated, each demands a separate notice.

The *prostatic* urethra is that portion of the tube which extends from the vesical orifice to the membranous portion, about a line behind the triangular ligament,—its posterior layer. This portion of the urethra passes through the prostate gland, from base to apex; lying at first above the middle lobe, and afterwards nearer to the upper than to the lower surface of the gland, by about two thirds of its substance below the urethra. The common ejaculatory ducts also converge under the base of the prostate, forwards and upwards, lying side by side for about an inch, between the middle and lateral lobes, and then pass through the gland to open on the floor of the prostatic urethra. This portion of the urethra has a fusiform or spindle shape, being widest in the middle, and constricted somewhat before and behind (Fig. 3). Its length is about one inch and a quarter; its breadth behind, at the neck of the bladder, is about a quarter of an inch; in the middle, it widens to a line or two more; and in front, at the commencement of the membranous urethra, the canal narrows again to rather less than behind. It is the widest and most dilatable portion of the whole urethral canal, although least extensible at the neck of the bladder. The mucous membrane of the prostatic urethra presents slight longitudinal folds, in a collapsed state of the passage; but a median ridge of mucous membrane and thickened sub-mucous tissue pro-

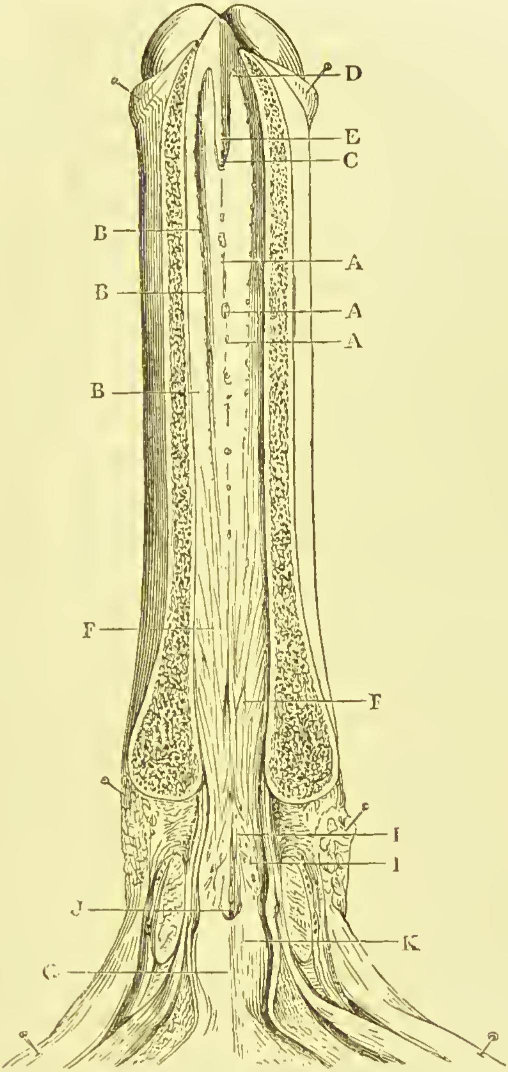

FIG. 3.—The mucous membrane of the urethra in Male. A, A, A. Lacunæ (of Morgagni). B, B, B. Foraminulæ (openings of minute glands). C. Fold of mucous membrane, forming a sort of valve to the fossa navicularis. D. Prolongation of the corpus spongiosum, forming the glans. E. Lacuna in the fossa navicularis (lacuna magna). F, F. Longitudinal folds of mucous membrane, effaced upon dilatation. G. Caput gallinaginis, or veru montanum. I, I. Orifices of the glands of Littré (small racemose mucous glands and follicles). J. Sinus pocularis. K. Mucous glands in the prostatic sinus of the urethra. (After Jarjavoy.)

jects in the floor of the urethra; extending from just in front of the little elevation, uvula vesicæ, at the vesical orifice, and gradually rising to a peak, it subsides rather abruptly towards the membranous urethra. This ridge is about three-quarters of an inch in length, but only a line and a half in depth, at its highest point. It is variously named the *crest* of the urethra, or *crista urethræ;* more commonly, *caput gallinaginis,* or *veru montanum.* On either side lies a depressed portion of the canal, the *prostatic sinus,* in the form of a longitudinal groove, and somewhat deeper behind at the vesicle orifice; the floor of either sinus is beset with numerous small apertures, the openings of the prostatic ducts from the lateral lobes, while those of the middle lobe open behind the central crest. In the crest, just in front of its peak, a small recess or *cul-de-sac* passes downwards and backwards between the lateral lobes, and beneath the middle lobe; at its orifice in the urethra, this *cul-de-sac* is about a line in width, but it enlarges to double that size at its fundus, a depth of about a quarter of an inch. This recess in the central crest is usually named the *sinus pocularis;* also the *vesica prostatica,* or the *utricle,* as being probably the analogue of the uterus in the female. It receives the two common ejaculatory ducts, which open by two narrow slit-like apertures upon or within the margins of the *cul-de-sac,* one on either side, or sometimes at the bottom of the fundus. Numerous small glands also open within this recess; and the crest has been found to contain erectile tissue, whereby, perhaps, when distended with blood, this central eminence may prevent any retroversion of semen into the bladder.

The *membranous* urethra reaches from the apex of the prostate to the bulb of the corpus spongiosum. It passes through the double membranous layer of the triangular ligament in the pubic arch, about an inch below the symphysis, but this portion of the urethra extends backwards for about a line behind the ligament, to the apex of the prostate, and forwards, a little in front, to the bulb. Having a curved direction upwards, the greatest length of the membranous urethra measures not more than three-quarters of an inch in the concavity, the convexity is even less, being overlaid by the bulb in front; and its diameter is less than that of any other portion of the urethra. The tube here lies over the end of the rectum, but separated by a cellular interval, where the bowel turns downwards; above, the dorsal vessels and nerve of the penis penetrate the triangular ligament; between the two layers of this ligament, the membranous urethra is embraced by the *compressor urethræ* muscle, consisting of two layers of transverse muscular fibres, one above, and one below the tube, attached to the ramus of the pubes on either side, and some circular muscular fibres surround this part of the urethra. The urethral compressor is known to surgeons as the "cut-off" muscle, from its function of voluntarily contracting the membranous urethra in the act of micturition, and thus abruptly arresting the stream of urine, as if by turning a stop-cock. This muscle is also the seat of spasmodic stricture of the urethra. When a catheter has passed through the compressor, and into the bladder, the stream flows uninterruptedly, and is no longer subject to voluntary control. Just beneath, and under cover of the lower band of fibres, are situated Cowper's glands; two little bodies, like peas, of a yellow colour, one on either side; above, lie the arteries of the bulb, one on either side—about half an inch above the base of the ligament.

The *spongy* portion of the urethra extends from the membranous part, at the bulb, to the external orifice, at the end of the glans penis. Continuing the curve of the membranous urethra up to the symphysis pubis, and then descending in the pendent penis, on its under surface, this portion of the urethra is enclosed in the corpus spongiosum. It is the longest portion of the whole urethra, measuring six inches, more or less, according to the length, and state of the penis; its diameter is somewhat dilated in the bulb—as the *bulbous sinus*, and again in the glans—forming the *fossa navicularis;* and in both these parts, the floor of the passage is most dilated. In the interval between these dilatations, the spongy urethra is of smaller size, about three lines in diameter; and at the external orifice, the urethra is even more contracted, that being the narrowest point of the whole tube.

In the course of the urethral canal, it should be observed that its size or *diameter* varies; there are *three dilated* parts—the *prostatic* sinus, the *bulbous* sinus, and the *fossa navicularis* in the glans penis—and of these, the first named is the widest part of the whole canal; other parts are more or less narrow, and the narrowest is the external orifice in the glans. The *form* of the canal is of less practical consequence, but a section differs in different parts of its extent; in the prostate, it has a triangular shape, with the apex downwards; in the membranous, and spongy portions of the passage, a transverse opening—except in the glans; and at the urethral orifice, which presents a vertical fissure opening—*meatus urinarius.*

The *mucous membrane* of the urethra is a prolongation of the genito-urinary; being continuous with that of the bladder, ureters, and kidneys, and with offsets lining the prostatic and ejaculatory ducts. The ducts of Cowper's glands pass forward in the membranous portion, beneath the mucous membrane, to the extent of an inch or more, and open by two oblique pin-hole apertures, in the floor of the bulbous portion of the urethra, at its fore part. The urethral mucous membrane has a reddish colour, but is paler in the prostatic portion; throughout its course this membrane is loosely connected by submucous tissue to the corpus spongiosum or erectile structure which encloses the tube; so that the mucous surface of the membrane presents longitudinal folds, which, however, are effaced when the canal is dilated during micturition or by the passage of an instrument. Numerous mucous follicles and lacunæ stud the surface, especially along the *floor* of the urethra, and in the bulbous part; but the largest—*lacuna magna*—is situated in the fossa navicularis, on its upper surface. These openings are directed forwards, towards the outer urethral orifice; a larger one than usual may, therefore, offer some hitching impediment to the passage of a small-sized instrument along the urethral canal.

The *corpus spongiosum* is that erectile structure which surrounds the urethra, from the end of the membranous portion to the external orifice of the urethra. Commencing just in front of the triangular ligament—rather behind the converging crura of the corpora cavernosa, which chiefly form the body of the penis—the corpus spongiosum appears in the shape of a flattened ovate extremity—the *bulb*, projecting backwards beneath the membranous urethra, in front of the triangular ligament; and sending backwards a thin layer of erectile tissue, which envelops the membranous and prostatic portions of the urethra, to the neck of the bladder; continued forwards as a cylindrical investment of the urethra, the corpus spongiosum lies in a groove or furrow on the under surface of the corpora cavernosa, at their junction in the middle line; but at their anterior truncated end, the spongy body enlarges over them and forms the glans penis. Around the vertical orifice of the urethra, the erectile structure forms two small lips, which when turgid with blood, as from congestion of the mucous membrane, constrict the urethral orifice to a smaller size than even in its usual state. This appearance is presented in acute urethritis or gonorrhœa.

The *muscles* of the urethra and penis are: the accelerator urinæ or ejaculator seminis, the compressor urethræ, already noticed, and the erector penis (Fig. 4), covering the crus on either side.

The *accelerator urinæ* has an important relation to the urethra. This muscle is a flat expansion of muscular fibres under and around the urethra, or corpus spongiosum, and extending from the bulb to the junction of the corpora cavernosa, at the converging crura. The muscle arises from the central tendinous point of

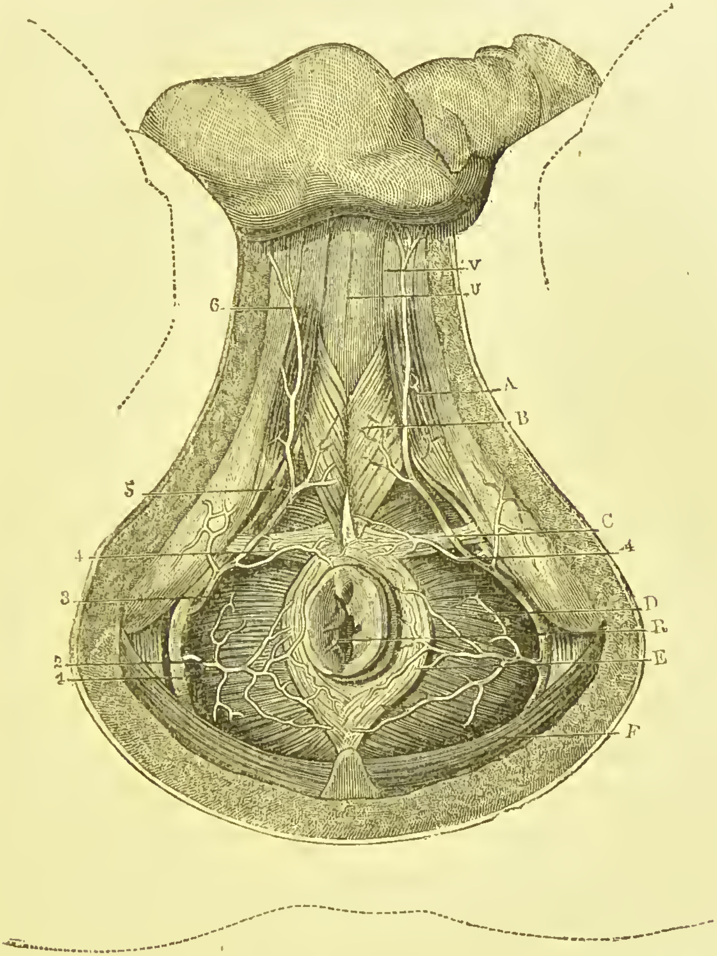

FIG. 4.—Arteries of the perineum, in Male. V. Corpus cavernosum. U. Urethra. R. Anus. A. Ischio-cavernosus or erector penis muscle. B. Bulbo-cavernosus or accelerator urinæ. C. Transversus perinei. D. Levator ani. E. External sphincter of anus. F. Gluteus maximus. *Arteries:* 1. Trunk of internal pudic. 2. Inferior hæmorrhoidal. 3. Superficial perineal. 4. Transverse perineal. 5. Dorsal artery of penis. 6. Terminal branches of superficial perineal. (From A. Jamain.)

the perineum, situated just below the bulb of the urethra —a point which also gives attachment to the sphincter ani, and to the two transverse muscles of the perineum;

from this point, a tendinous raphé, in the middle line, gives rise to fleshy fibres, thus forming a symmetrical bipartite muscle, which overlays the bulb and adjoining part of the corpus spongiosum; the two halves of the muscle, for the most part, pass round the spongy urethra, and are united above by a tendinous aponeurosis; but a band of anterior fibres, on either side, embraces the corpus cavernosum, at the junction of the crus, and are inserted into a fascia on the dorsum of the penis, over the dorsal vessels and nerve. The action of the urethral portion of this muscle is to expel any fluid, urine or semen, from the urethra, at the same time aiding in maintaining the turgescence of the glans penis; while the two penile bands of fibres will aid in maintaining the erectile state of the whole organ.

The *arteries* of the penis are branches of the internal *pudic* artery (see Fig. 4), namely, the two arteries of the bulb, distributed to the erectile structure of the corpus spongiosum; the dorsal artery, supplying the glans penis; and the two arteries of the corpora cavernosa, distributed to the erectile structure of these bodies, which constitute the body of the penis. The arterial vessels having penetrated the fibrous coat of the spongy and cavernous bodies, they ramify as a capillary network, supported by fibrous prolongations from the sheath, or trabeculæ; which, in the shape of bands and cords, in all directions, across the sheath, leave inter-trabecular spaces. A median fibrous partition—*septum pectiniforme*, separates the two corpora cavernosa; but the comb-like clefts of this septum, passing from the dorsal to the urethral margin, allow a free vascular intercommunication, except at the root of the penis where the septum is entire. Companion *veins* to each of the two pairs of arteries form venous plexuses, which occupy the inter-trabecular spaces, in the spongy and cavernous bodies; but the veins in the spongy structure do not communicate with those of the cavernous structure; the inter-trabecular veins, for the most part, emerge from the bulb, and cavernous bodies, at the root of the penis, and enter the prostatic plexus; while the dorsal vein, coming from the glans, and lying with the artery in the groove on the back of the penis, also enters the prostatic plexus of veins.

Lymphatics proceed from the urethral mucous membrane, that of the glans also, and from the skin of the prepuce, as a network, from which emergent vessels enter the inguinal lymphatic glands; but some *deep* lymphatics, from the spongy and cavernous bodies, pass under the pubic arch to the lymphatics in the pelvis.

This difference in the distribution of the penile lymphatics is practically important with relation to the seat of various diseases; lymphatic irritation or infection following the course of the superficial vessels, from chancre on the prepuce; whereas the deep vessels are affected by malignant disease of the erectile structures of the penis.

Nerves are supplied to the penis, corresponding to the arteries. They are derived from the *pudic* nerve, a branch of the sacral plexus of the spinal nerves; and from the *prostatic plexus* of nerves, an offset of the hypogastric plexus of the sympathetic. Thus, from the *pudic* nerve (Fig. 5) proceeds the dorsal nerve, distributed to the glans, but also supplying a large branch to the corpus cavernosum on each side, and integumental branches to the prepuce, dorsum and sides of the penis. The two superficial perineal nerves, from the perineal branch of the pudic nerves, supply the scrotum and the under surface of the penis; and from the same source also are derived muscular branches, to the accelerator urinæ, and to the erector penis, as well as a branch to the transverse muscle of the perineum. The pudic nerve likewise gives off the nerve of the bulb, which is distributed to the corpus spongiosum, around the urethra.

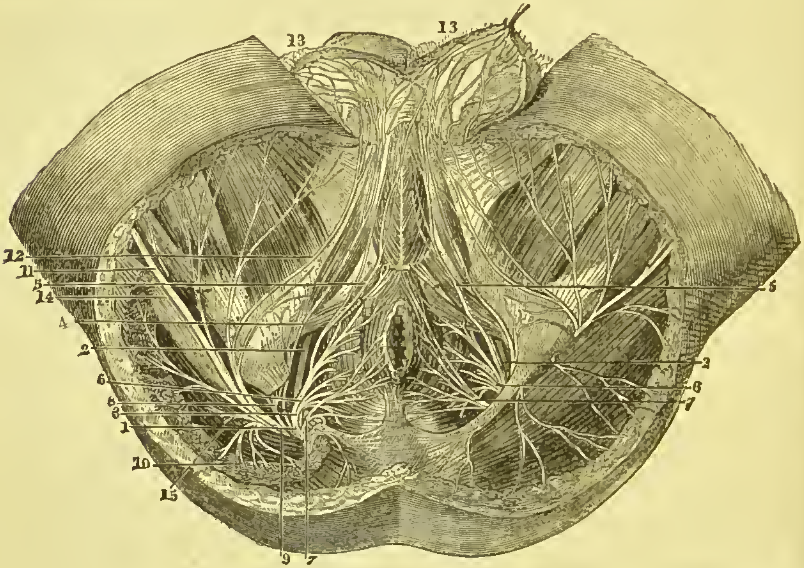

Fig. 5.—Perineum, in Male; showing nerves. 1. Internal pudic. 2. Dorsal nerve of penis. 3. Perineal nerve. 4. External superficial perineal branch. 5. Internal superficial perineal branch. 6. Musculo-bulbal nerve. 7. Inferior hæmorrhoidal. 8. Nerve to internal obturator muscle. 9. Small sciatic nerve. 10. Muscular of small sciatic to gluteus maximus. 11. Genito-crural. 12. Inferior pudendal nerve. 13. Nerves of dartos (network of inferior pudendal on scrotum). 14. Great sciatic nerve. 15. Nerve to pyriformis muscle. (After Hirschfeld and Léveille.)

But the prostatic plexus of the sympathetic nerve supplies an offset to the corpora cavernosa, some cavernous filaments also penetrating the corpus spongiosum; and these cavernous nerves communicate with the dorsal nerve of the pudic.

Female Urethra.—In the female the anatomical peculiarities of the urethra are practically important with

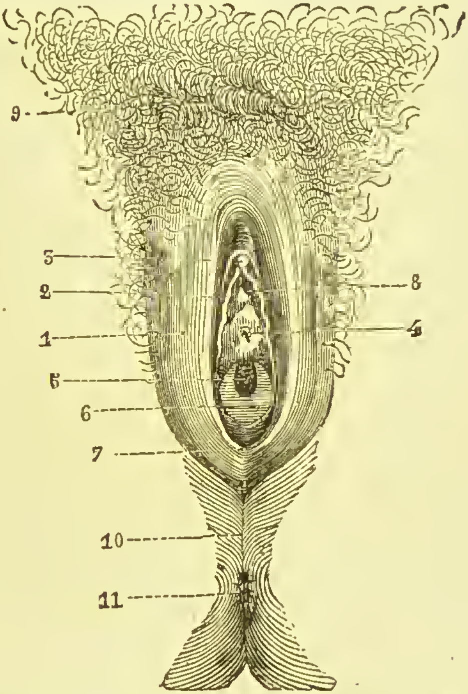

FIG. 6.—External genitals, in Female. 1. External labia. 2. Internal labia or nymphæ. 3. Clitoris. 4. Meatus urinarius. 5. Opening of vagina. 6. Hymen. 7. Fourchette. 8. Vestibule. 9. Mons veneris. 10. Perineum. 11. Anus. (From A. Jamain.)

reference to the introduction of an instrument through this passage, as in catheterism; and also in the selection and performance of operations for the removal of stone from the bladder. The uretheral canal is shorter, wider, and straighter than in the male. Averaging in length only one inch and a half; its diameter is a quarter of an inch, or more, but enlarged and funnel-shaped adjoining the neck of the bladder, narrowed at the external orifice, with a dilatation in the floor of the urethra near the meatus. The course of this canal is nearly straight, having a slight curve below the symphysis pubis, the concavity looking upwards.

Lying in the middle line, the urethra passes from the bladder through the triangular ligament, in the pubic arch, to the external orifice; but, throughout its course, the tube is embedded in the texture of the upper or anterior wall of the vagina, the compressor urethræ muscle embraces it in the arch of the pubes, between the two layers of the triangular ligament, and behind this structure, the anterior ligament of the bladder overlays the vesical portion of the tube. Owing, however, to the comparative absence of unyielding structures around the urethral tube, it admits of dilatation much more readily than the male urethra. The external orifice, or *meatus urinarius*, is a small, round opening, set in an elevation; it is situated within the vulva, immediately above the entrance to the vagina, and below the symphysis pubis, about an inch beneath and behind the clitoris, and between the commissure of the inner, smalle labia, or nymphæ (Fig. 6).

The urethral tube consists of mucous membrane wit an outer layer of circular muscular fibres, in sub-mucou cellular and elastic tissue, enveloped by a vascular structure containing a plexus of veins. The mucous membran has a pale colour, except adjoining the external orifice and it presents longitudinal folds, one more especially, in the floor of the canal, which corresponds to the median crest in the prostatic portion of the male urethra. Numerous tubular mucous glands lie between the folds of membrane, with their apertures directed towards the bladder; and mucous follicles open within, and around the outer orifice of the urethra. Both these forms of gland are of larger size towards the more external portion of the tube. The *vessels* and *nerves* proceed from those which supply *the vagina.*

CHAPTER I.

FUNCTIONAL DISORDERS.

I SCARCELY need observe that Pathology recognises two forms of disease—derangements of function and alterations of structure; both forms of deviation being estimated by comparison with a presumed standard of health. Alterations of structure, including those of physical character and chemical composition, are together represented by Pathological Anatomy, while Pathology proper is thus restricted to disorders of function. Such then is the general nature of Pathology, and such its more limited and usual signification.

The two conditions of disease are frequently associated, if not inseparably united. But diseases of structure *precede* their functional manifestations. It may be that the earliest alterations of structure are minute, and therefore likely to escape detection; or that such alterations relate only to the vascular condition of the tissue or organ affected, and that they are almost or altogether effaced previous to a post-mortem examination (should the disease prove fatal), and thus many nervous diseases may appear purely functional; but instances of functional disturbance *alone* are very doubtful, and are gradually being reclaimed to altered structure. Functional deviations from the standard of health have no significance apart from their preceding and accompanying alterations of structure; and common experience reminds us of many instances of sudden death, where chronic organic lesions have been discovered, the existence of which had never been even suspected by the patient, or the practitioner, during life.

Clinical investigation, therefore, may commence with some disorder of function,—of which perhaps the patient complains, and for which he seeks remedy or relief; but in our examination, we should always seek to connect that disorder with an allied alteration of structure in the organ or part affected,—as being the internal *cause* in operation. The organ which was primarily the seat of structural change, may be *remote* from that which first attracted attention; and thus a mere local functional disturbance may prove to be a symptom of disease in operation at perchance some distance off in the body, and which, therefore, would not *appear* to be the cause of the topical disturbance—through the medium of the organ secondarily at fault. Hence the value of many *symptoms*, which although themselves comparatively insignificant, may yet guide us to the detection of latent disease in some distant, and hitherto unsuspected organ. Irritability of the urinary bladder, for instance—representing only a more or less painfully urgent desire to frequently discharge the contents of the bladder—is a functional disorder of this organ, which, arising often from some morbid condition of the urine, may prove to be the local symptom that first directs attention to this condition; itself due to a far more grave disease of the kidneys, the stomach, the blood, or the nervous system.

By pursuing the investigation of internal causes, we may be led to discover some *constitutional* condition, as distinguished from any localized disease. If we seek to analyze the nature of constitutional causes, they may perhaps be reduced to the agency of the *blood* in circulation throughout the body, and to the general distribution of *nervous* influence from the central nervous system—cerebro-spinal and sympathetic—to every part. The *nervi-vasorum* accompany the blood-vessels in their distribution to every constituent organ, and nearly every component tissue of the body; regulating the quantity of blood supplied through the capillary vessels, if not somewhat affecting the quality of the vital fluid, in every part. These two agents—the blood and the nervous system—are together the bond of functional union and sympathy between distant parts; and thus may be explained the intimate relations which subsist between their diseased conditions.

Bearing in mind these general considerations respecting the connection of functional with structural conditions of disease, and also as to the investigation of internal causes, local and constitutional,—we are prepared to enter into the pathology, and thence the treatment of diseases pertaining to, or affecting, the urinary bladder.

This organ is subject to various functional disorders, which apparently may, or may not, depend on alterations of structure; or be referable perhaps to latent constitutional causes.

These disorders of *function* comprise:—(1) irritability of the bladder, with frequent and painfully urgent micturition; (2) spasmodic action; (3) neuralgia; (4) paralysis; (5) impotency, or 'stuttering' of the bladder; (6) atony; (7) engorgement of the bladder, and overflow of urine; (8) incontinence; (9) retention of urine.

The anatomical *structure* of the bladder—as already described—has important relations to these different functional disorders of this organ.

IRRITABILITY OF THE BLADDER.—The healthy irritability of the urinary bladder is the vital property of the muscular bands, in its middle coat. Stimulated by the urine contained in the bladder, this middle layer contracts both vertically and transversely—as the detrusor urinæ muscle—the sphincter muscle of the bladder being voluntarily relaxed; and thus, aided by the voluntary action of the abdominal muscular parietes compressing the viscera downwards on the bladder, the contents of this organ are expelled, as occasion may require. In the intervals of micturition, the tonic contraction of the muscular or middle coat of the bladder maintains a certain compressive action on the contained urine, resisting over-distension of the organ. The pathological condition of increased irritability or contractility is immediately referable to the same *muscular* constituent of the bladder, and this morbid state induces *frequent* micturition; but the *painfully urgent* character of the desire to expel the urine, more frequently, is due to a similar exalted sensibility of one or other systems of *nerves*, or may be referable to both. From being so frequently emptied, the bladder becomes, at last, less capacious than natural, and unable to hold the average quantity of urine.

Irritability of the urinary bladder—thus a musculo-nervous functional disorder of this organ—has a wide-spread etiology, comprising both local and constitutional causes; the latter relating to morbid states of the blood or of the nervous system, and connected often with various hygienic and social habits of life.

In tracing these causes, it should be remembered that the bladder has its nervous and vascular relation to surrounding organs, as well as to organs distant in the body. On the other hand, the organ itself may be the seat of irritation, in disease of the bladder; or its contents may be the source of direct irritation, as by the presence of morbid conditions of urine, blood, or stone in the bladder.

All the causative conditions of vesical irritability may be arranged under the following heads:—

Local Causes.—(1) Habitual Constipation and Diseases of the Rectum; principally—hæmorrhoids, fissured anus, inflammation of the rectum, stricture of the bowel, cancer, abscess about the rectum, fistula in ano, and ascarides: (2) Displacements and Diseases of the Uterus and Vagina; chiefly—prolapsus uteri, or vaginæ, metritis or inflammation of the uterus, cancer, fibrous or other tumour, and ovarian disease, or disordered menstruation: (3) Stricture of the Urethra, organic, spasmodic, inflammatory, also phimosis, and urethritis, as gonorrhœa, or gleet: (4) Diseases of the Prostate Gland; chiefly—hypertrophy or chronic enlargement, prostatitis or inflammation, cancer, or other tumours; and sexual excess: (5)

Diseases of the Bladder; principally—cystitis or inflammation, acute and chronic, cancer, hæmaturia or blood in the urine, stone; hernia. Morbid conditions of the urine itself, rank as local causes of vesical irritability, by their direct operation on the interior of the bladder; but, as pertaining to Urinary Pathology, they are included under the second general heading.

Constitutional Causes.—This great class of causes embraces (1) Morbid conditions of the Blood, (2) those of the Nervous System.

Morbid conditions of the *blood* result from perversions of the blood-forming processes: (*a*) by mal-assimilation, primarily in the process of digestion, or secondarily in the process of nutrition; (*b*) by mal-excretion, through the kidneys, the skin, or the liver. Diseases of the *organs*, severally concerned in these processes, give rise to the consequent blood conditions; and they, in their turn, are manifested by corresponding states of the urine, and urinary deposits; the whole constituting Urinary Pathology. In relation to irritability of the urinary bladder, the organic conditions are remote causes, the urinary conditions are direct or immediate causes; while the blood-vascular system is the medium of communication. The chief of these urinary diseases are, lithic acid and lithates; oxalates; and phosphates. As a sequel of various eruptive fevers, vesical irritability may also be referable to blood-poisoning.

Morbid conditions of the *nervous system* comprise diseases of the nervous centres—brain, and spinal cord; and of the ganglionic centres of the sympathetic nervous system. Diseases of these central *organs*, and of organs generally, being severally connected through the medium of nervous influence, they may thence become causes of irritability of the urinary bladder. Whatever may be the essential pathology of hysteria, no disease manifested through the nervous system is more often attended with vesical irritability. Depressing passions, such as grief, anxiety, or fear, and nervous exhaustion; or mental excitement, as anger, are also causes of this affection. With neuro-etiology may be associated the operation of sudden exposure to cold; or the influence of heat, especially upon the head, and sunstroke.

It thus appears that diseases of organs *distant* in the body, from the urinary bladder, are brought to bear upon this organ, through the agency of the vascular and nervous systems; just as *local* diseases generally operate, in like manner, upon this organ.

Hence the widespread etiology of irritability of the bladder. This affection is, therefore, not merely a symptom which may be selected for the convenience of associating much valuable clinical experience pertaining to diseases, different in themselves. As a symptom it may also have a very important *etiological* significance, by leading to the discovery of latent disease, in perchance some distant and previously unsuspected organ or part of the body; while the continued influence of such disease, and thence its *prognosis*, may perhaps be determined by the persistence of the vesical irritability.

Treatment.—Remedial measures must have reference to the removal of any cause or causes, local or constitutional. The treatment of *local* causes relates to the various diseases of the bladder and adjacent organs, already enumerated. Excluding diseases of the rectum, and those of the uterus and vagina, the diseases of the bladder, prostate gland, and urethra will be fully noticed in the course of this treatise. *Constitutional* causes also, both from a remedial and preventive point of view, are fully considered with Urinary Diseases and Deposits.

But in the treatment of vesical irritability, the *hygienic* origin of constitutional disease, conjoined with social habits, should always form the subject of special inquiry. Thus, the mal-assimilation of food in the process of digestion is often referable to *errors of diet;* followed perhaps also by rectal constipation. The correction of any such dietetic error, by proper injunctions to the patient, must not be overlooked, or medicinal agents will be prescribed in vain. The practitioner may have to deal with dyspepsia or indigestion in its various manifestations; the distinctive symptoms of which seem due to the nerves, blood-vessels, and muscular fibres of the stomach. Thus we recognise irritable dyspepsia, associated with pain after food, nausea, or actual sickness, and acidity; the inflammatory variety, known by the same gastric symptoms; coupled, however, with general febrile disturbance; while atonic dyspepsia is distinguished by abdominal distension, flatus-eructations, lethargy, and general debility. We may not always succeed in connecting this or that form of indigestion with this or that error of diet; but the atonic variety is often associated with excess of vegetable food; while irritable and inflammatory indigestion, followed by a gouty tendency, lithic acid or lithates in the urine, and irritability of the bladder, proceed frequently from an undue proportion of the more stimulating species of animal food. Nor are the artificial resources of the *cuisine* wanting to perplex the stomach, in all the treacherous forms of "made-dishes;" ignoring the great object of cookery,—to prepare food for digestion, or solution in the stomach, as well as to make it palatable.

Among diseases of, or affecting the nervous system, *hysteria* is commonly engendered by a vicious social training in youth, and by a similar existence in after-years. "You can render"—observes Sir B. Brodie—"no more essential service to the affluent classes of society than by availing yourselves of every opportunity of explaining to those among them who are parents how much the ordinary system of education tends to engender the disposition to 'nervous affections' among their female children. The boys are sent at an early age to school, where a large portion of their time is passed in taking exercise in the open air; while their sisters are confined to heated rooms, taking little exercise out of doors, and often none at all, except in a carriage. Then, for the most part, the latter spend much more time in actual study than the former. The mind is over-educated at the expense of the body, and, after all, with little advantage to the mind itself; for who can doubt that the principal object of this part of education should be, not so much to fill the mind with knowledge, as to *train* it to a right exercise of its intellectual and moral faculties, or that, other things being the same, this is more easily accomplished in those whose animal functions are preserved in a healthy state, than it is in others?" Again, it may be that the social condition of an individual exempts him or her from the necessity of any daily occupation. The intellectual faculties, not being roused by the stimulus of any professional avocation or the pursuit of trade, are prone to inactivity. Under such circumstances, the emotions are apt to be lively. Hence the origin, or at least one source, of that peculiar morbid susceptibility, the sensitiveness of those who are "all feeling;" hence that restless apprehension of some impending evil, the very offspring of luxury and ease; hence, sometimes perchance, that suicidal melancholy, "which rejoiceth exceedingly and is glad when it can find the grave." If, however, through intellectual lethargy, an emotional character be developed, such a person often becomes the victim of painful sensibility—bodily, as well as mental. An original observer* truly remarks—"Such persons are commonly called nervous. They are worried with trifles, startled at shadows, distracted by noise or bustle, never free from some ache or pain, almost every feeling is suffering; what in others would be slight pain, in them amounts to agony. Hence they are perpetual invalids, quite unfit for the rugged path of life, over which they walk, as it were, barefooted and thinskinned."

Among persons, more commonly such as these, in youth, and after-life, may be noticed the victims of *local* nervous affections: they are subject to that piercing kind of headache known as *clavus hystericus;* spinal and abdominal tenderness; pains in the breasts and joints. With pains, and penalties, thus flying about the body, as local manifestations of an undue general sensibility, various perversions of the special senses are perhaps associated. The taste may prefer wormwood to honey, and chalk rather than cheese; the eye may be intolerant of light; every smell may be a stench, and every sound a discord. To these depraved sensations may be added certain functional derangements of the internal organs, proceeding from excitement of either the great sympathetic or spinal nervous systems. Thence, palpitation of the heart and breathless agitation, with a distressing sensation of choking, from the rising, as it were, of a ball in the throat; attacks of hoarseness or loss of voice, of hiccough or dry loud coughing, of vomiting, or diarrhœa; and the frequent occurrence of an irritability of the bladder, which is accompanied with the abundant discharge of a pale, limpid, watery urine. Lastly, these phases of nervous excitement occasionally terminate in a sudden and violent paroxysm, or *fit*, of involuntary, or at least perhaps uncontrollable movements; although consciousness is retained,—unlike an epileptic seizure, even when unattended with convulsions, but occurring only as a sudden and brief loss of consciousness.

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* "Principles of Medicine." C. J. B. Williams.

Such then is the social origin and general character of the ordinary functional disturbances of the nervous system, which taken collectively, have received th inappropriate name of Hysteria—a word which, from it etymological meaning, would imply some disease of th uterus, but which in reality is not peculiar to the femal sex; being occasionally witnessed in males, as the ex perience of every medical observer, and indeed commo experience, will testify. The frequent occurrence uterine disorder, in connection with hysteria, is co sistent with the nervous endowments of the organ affected; by virtue of which, it—the uterus—is so intimately related to the entire nervous system, as to respond most promptly to its prevailing condition, whatever that may be. But the nervous excitement of hysteria does not emanate from the uterus; for in most cases the function of menstruation is not impaired in the first instance; while sometimes that function continues to be fulfilled regularly and sufficiently, and seldom the organ itself presents any organic disease or displacement.

The *treatment* of hysteria—as a constitutional disease, and having regard to its social origin—will assuredly *not* consist in the administration of uterine remedies; nor in the rash, repeated, and demoralizing introduction of a vaginal speculum, to inspect what?—"a prominent spot of varying size;" "a something raised;" "an abrasion or erosion." The judicious practitioner will begin by searching out those causes—physical, mental, or moral—which have produced the hysteric diathesis. Its evil origin lies often in the depths of a vicious education; an indoor life, with high-pressure schooling for accomplishments; while in after years, the hysteric patient is often the victim of that *ennui* and mental fallowness, or moral perversion, which proceeds from the want of a daily occupation of the head and heart with something better than mere passing circumstances, the pursuit of some object in life, worthy of a rational and responsible being. No medicinal treatment can avail under any such adverse circumstances; but when they are corrected, then the known resources of medicine may do much to relieve, if not to cure, the *symptoms* of hysteria. The nervous excitement is frequently accompanied with general debility, and muscular irritability, especially of the urinary bladder. Tonics and antispasmodics may, therefore, be prescribed with advantage. And in these two classes of medicine, none are so efficacious as cinchona or cascarilla bark, and sulphuric ether or the ethereal compounds. In the case of a young married woman, under my care, an uncontrollable desire to micturate occurred every few minutes; yet this vesical irritability subsided under these remedial measures, and she contained her urine for the full average period. At the same time, one should not overlook the benefit to be derived sometimes from preparations of valerian and assafœtida; the nitrate of silver, or the sulphate of zinc; or the preparations of iron or copper. The careful regulation of the diet is of paramount importance; for the appetite, although sometimes voracious, is rarely selective of digestible food; and the digestive process itself is often imperfect, resulting in mal-assimilation, and constipation alternating with fitful diarrhœa, lumpy fæces passing from the cells of the colon or which were impacted in the rectum. In such cases, the attacks of vesical irritability are generally most distressing. Here the action of assafœtida proves specially beneficial; or, a dinner-pill of gentian and aloes will prevent or remove the oft-recurring source of intestinal irritation. Rectal constipation is perhaps best relieved by the simple *lavement* of cold water, or an enema of soap-suds and castor oil, as occasion may require.

Lastly, as a topical sedative to irritability of the bladder, from whatever cause, I have used suppositories, with satisfactory reports in their favour; the usual form having been Pil. Saponis Co. introduced into the bowel at night, when sleep would otherwise be disturbed by the frequency of micturition.

Two other affections of the bladder, akin to irritability of this organ, are occasionally met with.

Spasm of the bladder is said to be an involuntary and exceedingly painful contraction, occurring from time to time; the cause being various,—inflammation, stone, a morbid growth or tumour. Van Buren refers some cases of vesical spasm to chorea; there being sometimes an association of choreic symptoms. He gives three such cases, all occurring in childhood, and of which the following seems to be the most illustrative. A. B., aged eight, is a fat, healthy, lymphatic boy, one of a large family of children, of whom nearly every male has distinct chorea, either generalized or affecting special muscles. Some of the older children have outgrown the tendency. The patient is troubled occasionally with slight general choreic twitchings, when from any cause his appetite is low, or his general health poor. Under such circumstances, he has frequent paroxysms of intermitting, uncontrollable contraction of the bladder, forcing him to frequent micturition and attempts at emptying the bladder every few moments. Sometimes the call comes so suddenly that he wets his clothing, and he also is unfortunate at night. When the boy is enjoying good general health, neither his general chorea nor his frequent calls to urinate disturb him. He improves under arsenic, quinine, or any general tonic or country air. Spasm, like irritability, is a symptom only, of which disease is the cause. I am disposed to regard both these symptoms as the same, differing in their degree of intensity; spasm representing excessive irritability of the bladder, with an acutely painful urgency as well as frequency of micturition. The *treatment* is that of cystitis; and the removal of any foreign body from the bladder, as a calculus, by the operation of lithotomy rather than by lithotrity.

Neuralgia, or an excessive sensibility—hyperæsthesia—of the neck of the bladder and prostatic urethra, is denoted by similar symptoms; but the act of micturition is more especially painful, and there may be at times seminal emissions with erections, in the form of active or spasmodic spermatorrhœa. Paroxysms of acute pain may occur. Vesical neuralgia is unaccompanied with any apparent organic disease. A correct diagnosis is very important; lest perchance stone in the bladder, or some disease of the organ, be mistaken for neuralgia; or the worse error be committed, of attributing a neuralgic condition to some such organic cause, which would sadly mislead the treatment. This painful affection seems to arise more often from some constitutional cause, resulting in a generally depressed state of the nervous system and of the circulation; especially, from the blood-condition of chronic gout or rheumatism, or the anæmia of malarious poisoning; thus illustrating the truth of Romberg's graphic expression—that "neuralgia is the prayer of the nerve for healthy blood." But vesical neuralgia may also proceed from rectal constipation, the constant excitement induced by sexual excesses, or of ungratified desire, habitual masturbation, or other local causes of nervous irritation. On passing an instrument, the urethra is found to be over-sensitive and contractile; but in the membranous portion, the point of the instrument is grasped and arrested; or having passed into the prostatic urethra, the patient experiences great pain and becomes faint, or has a sexual orgasm of an hysterical character; and on entering the bladder, the vesical neck is equally sensitive or painful, and spasmodic desire to micturate is provoked. On withdrawing the instrument, a drop or two of blood may follow, but the symptoms are often relieved for a while; the sensibility and contractility having been exhausted by the compression of the instrument in the urethra.

Treatment consists in the removal of any causative condition, and the administration of anodynes or the use of suppositories, with tonics, especially the preparations of iron, arsenic, quinine, and strychnia; a well-regulated diet and state of the bowels, change of air, and other hygienic resources. One of the worst cases I ever had to manage was in an old, enfeebled debauchee, and whose rectum was often loaded with the feculent matter of hard, undigested food. He became much relieved under this plan of treatment, and especially by attention to the rectal constipation. The passage of a full-sized conical steel sound always affords relief after using this instrument; but it should not remain in the urethra longer than a minute or two, nor be re-introduced oftener than every other day, lest it become an irritant, instead of having a sedative and tonic influence on the urethral nerves, muscles, and vessels.

PARALYSIS OF THE BLADDER.—This functional state of the bladder signifies a loss or impairment of the contractile power of its muscular fibres, by failure of the nervous influence to this organ. The causes of vesical palsy are of two kinds. It usually depends on some lesion of the brain or spinal cord. Thus, it may occur in connection with injury to the head or spine; or from disease, as apoplexy, softening, or other structurally destructive disease of the nerve-centres. But the paralysis may depend on functional conditions: as in hysteria, spinal debility from sexual excesses; reflex action from some source of irritation, as hæmorrhoids and after operations for their removal; the shock of injury, the result of fever; and the influence of certain medicinal agents, as belladonna, hyoscyamus.

The prognosis of vesical paralysis, as arising from these two classes of causes, differs considerably. Functional disturbances of the nervous system, for example, have only a temporary effect, the bladder regaining its expulsive power; whereas structural lesions of the nerve-centres are not only of a persistent character, but they involve other parts, besides paralyzing the bladder. Paralysis of the bladder alone, with retention of urine, or of its neck only, with incontinence, is extremely rare; such cases of apparent paralysis are usually states of atony, resulting from over-distension. A paralyzed bladder at last becomes atrophied, the walls getting thinner from loss of innervation, and perhaps undergoing fatty degeneration.

The retention of urine, and a distended state of the bladder, can be readily ascertained by percussion above the pubes; the bag of fluid emitting a dull sound when percussed in the usual manner, and the area of dulness may gradually extend up to the umbilicus, as the bladder becomes yet more distended with urine. A portion of the urine may be discharged, although the bladder is paralyzed, by the compressive action of the abdominal muscles, in the voluntary straining efforts of micturition, the urine being expelled in a slow stream, and up to a certain amount. But the greater quantity of urine is retained, and the bladder remaining nearly full, soon again becomes distended.

Treatment.—Whatever may be the cause of vesical paralysis, the retention of urine will constantly engage the surgeon's attention. The urine must be drawn off, and the bladder emptied two or three times a day by means of a full-sized catheter. This instrument should be used gently, even when an elastic catheter is introduced, the bladder having lost its sensibility to pain when injury is inflicted, and the urethra being often in a lax state. The stream of urine will be small or perhaps dribbling, for the bladder has lost also its contractile power; the propulsive action now depending on the compression produced by the abdominal muscles alone, when not involved in the vesical paralysis. Chronic cystitis is apt to supervene; a low inflammation of the mucous membrane of the bladder, partly as the result of frequent distension of the organ, but principally consequent on the deprivation of nervous influence. This inflammatory state should be treated chiefly by local measures; injections of tepid water to wash out the fœtid, ammoniacal, muco-purulent matter from the bladder; followed by weak astringent injections, as the dilute nitric acid, say ten or fifteen minims to the ounce of water, which may be allowed to remain in the bladder for a minute or two. These injections should be regulated by two considerations: the decomposed state of the purulent matter tends to maintain the cystitis; and the greater tendency of the mucous membrane to ulceration from paralysis of the bladder, rather than in ordinary chronic cystitis. Of course, a non-metallic instrument must be used for an acid injection. Curative treatment will have for its object, the restoration of innervation—the supply of nervous influence to the bladder. But remembering the nature of certain causes of vesical paralysis, it may be hardly possible to hope for a successful result; as in fracture of the spine. In chronic cases—when not depending on any persistent cause—strychnia, iron, arsenic, cantharides, and ergot of rye, may prove beneficial; while, of local measures, blistering, cold douches, and electricity are the most promising. The latter is applied directly to the bladder, by passing up an insulated electrode, with the opposite pole over the hypogastrium or in the rectum.

Hysterical paralysis should be treated by constitutional measures only; for if the retention of urine be relieved by the habitual use of the catheter, the patient's attention becomes more fixed on her malady, and the defective voluntary effort on which it depends will thus be cultivated. The attack usually passes off. In the event of such prolonged retention, that the bladder has lost its power of contraction, then, of course, relief must be given by catheterism, as may be necessary. But it behoves the young practitioner to be familiar with the tricks which hysterical patients are apt to play, in feigning an inability to pass water, or some other trouble as if referable to the bladder, and which would mislead as to the necessity for surgical interference. Sir Thomas Watson thus notices some such habits of urinary deception: "It is a common trick with these (hysterical) patients to pretend that they are labouring under retention of urine, and cannot make water. The daily introduction of the catheter, by a dresser or an apprentice, appears to gratify their morbid and prurient feelings. Sometimes, no doubt, the difficulty is real; but it is oftener feigned or exaggerated. I have again and again known it disappear upon the patient being left without pity to her own resources. But girls have been known to drink their urine, in order to conceal the fact of their having been obliged and able to void it. The state of mind evinced by many of these hysterical young persons is such as to entitle them to our deepest commiseration. The deceptive appearances displayed in the bodily functions and feelings, find their counterpart in the mental. The patients are deceitful, perverse, and obstinate: practising, or attempting to practise, the most aimless and unnatural impositions. They will produce fragments of common gravel, and assert that these were voided with the urine; or they will secrete stones and cinders in the vagina, and pretend to be suffering under some calculous disease. A young woman contrived, in one of our hospitals, to make the surgeons believe that she had stone in the bladder, and she actually submitted to be placed upon the operating-table, and to be tied up in the posture for lithotomy, before a theatre-full of students;

and then the imposture was detected. Sometimes they simulate suppression of urine, and after swallowing what they have passed, vomit it up again, to induce the belief that the secretion has taken place through the new and unnatural channel."

IMPOTENCY OF THE BLADDER.—Inability to void urine sometimes arises from *defective co-ordination* of the muscular actions which are engaged in micturition; the action of expulsion, and the relaxation of the sphincter vesicæ, not being in concord. This muscular discord—from its analogy to the failure of muscular co-ordination in "stuttering"—has been designated by Sir James Paget, "stammering of the bladder." But the term impotency of the bladder, would seem to be more correct; just as sexual impotency may be due to the want of co-ordination between the muscular actions requisite for penile erection and seminal emission simultaneously. In the endeavour to expel urine from the bladder, any concentration of the person's attention on the act of micturition, or any diversion of his attention, as by the presence of another person, will alike tend to disturb the harmony of this procedure. And, whatever be the circumstances under which such interruption has once occurred, their repetition will assuredly cause the difficulty to recur. The victim of an impotent bladder learns by experience not only to avoid the adverse circumstances of this failure to micturate, but he learns also the place, the attitude, and associations which are most conducive to his success in the act.

The *treatment* of vesical impotency will depend very much on the patient educating himself to overcome his own difficulties in relation to passing urine, and to gain confidence in his power. The surgeon's duty, therefore, will be to honestly explain the nature of the case to him, and to encourage his self-control over the act of micturition. The patient may be taught to use a catheter, as a last resource for relief; but even this knowledge may prove prejudicial, if it should prevent him relying on his own resources to bring his bladder into action. Such, at least, has been my experience in not a few cases of impotent bladders, in nervous, bashful young men, among whom this troublesome complaint usually occurs. No medicinal agents have any certain efficacy, but I would suggest the trial of valerianate of zinc.

Atony, from Over-distension.—Unlike paralysis of the bladder, which proceeds from the failure of its contractile power, giving rise to retention of urine, atony of the bladder arises from retention, amounting to distension, which overcomes the contractile power of this organ. Over-distension is the result of some organic obstruction, usually stricture or enlarged prostate, impeding the evacuation of urine. The resistance thus offered to the passage of urine, or by its accumulation, is greater than the expelling force. After each act of micturition, therefore, the bladder is incompletely emptied. The residual urine maintains some degree of distension, relieved from time to time by strong expulsive efforts, or by relaxation of the sphincter during sleep. But the bladder gradually becomes overstretched, and losing its contractility, remains in an atonic state and enlarged (Fig. 7). Chronic cystitis often supervenes.

The *treatment* of vesical atony must have regard to the removal of any cause of obstruction to the free passage of urine, and the prevention of any retention; so that the bladder may recover its normal tone. The urine should be regularly drawn off once or twice daily; and only a small slow stream will be procured, owing to the atonic state of the bladder. But as the organ regains its power, injections of cold water may be used with advantage,—not more than three or four ounces being thrown in, to avoid distension of the already enlarged bladder; and medicinal treatment, of a stimulant and tonic character, as in vesical paralysis, may also have a beneficial effect.

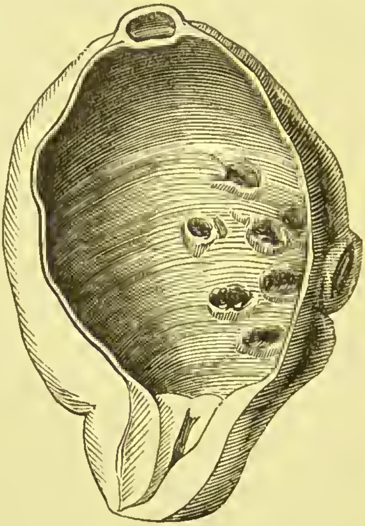

Fig. 7.*

Engorgement of the bladder and overflow of urine, is a condition allied to atony from over-distension. Engorgement arises from enlargement of the prostate, which rising up at the neck of the bladder, forms a receptacle in the fundus, wherein urine accumulates. The urine rising above the level of the prostate, distends the bladder to engorgement, when a portion of the fluid escapes as an overflow, and the distension may be relieved down to the level of the prostate. But there is still partial retention, and instead of the occasional overflow, the bladder may remain engorged; and then over-distension at length results in atony of the bladder, with complete retention. This result is not unfrequently induced by a "prostatic attack;" exposure to cold, or an irritant state of the urine, may provoke the prostate to further enlargement than usual, and cause retention sufficiently to require the aid of catheterism for relief; but when this attack subsides, and the instrument passes readily, the bladder has relaxed into an atonic condition, so that the patient himself cannot pass water. Such was the case in a somewhat elderly surgeon whom I attended, and whose bladder never regained its tone.

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* St. Thomas's Hosp. Mus., BB. 10. Atrophy, and sacculation of the bladder.

The *treatment* by catheterism, peculiar to enlarged prostate, will be described hereafter.

INCONTINENCE OF URINE.—Hitherto I have described those functional disorders of the bladder, which are manifested by frequent micturition, whether from vesical irritability, spasm, or neuralgia; or, again, in which the central symptom is retention of urine more or less completely, whether from vesical paralysis, vesical impotency, atony, or engorgement with overflow. I have yet to notice incontinence, or an involuntary escape of urine; a symptom of one or other of two opposite conditions: in one, the bladder does not retain its contents; in the other, the bladder is full, almost to repletion.

An involuntary escape of urine differs from frequent micturition, which is of a voluntary, although painfully urgent, character. But incontinence of urine is not necessarily symptomatic of deficient voluntary power of retention. In *childhood,* when this power is temporarily suspended during sleep, the sphincter of the bladder may be relaxed, and then the urine runs off until the bladder is empty; in *adult* life, an over-distended bladder may relieve itself, a certain quantity of the urine running off, but leaving a quantity still retained, and this incontinence may happen during sleeping or waking. An involuntary escape of urine in the adult, always indicates a distended, not an empty state of the bladder, after it has occurred. Sir B. Brodie takes exception to this rule, in some cases of paralysis of the lower limbs, where the bladder seems incapable of distension. He adduces a case in which paraplegia was caused by swallowing a liniment containing the tincture of cantharides. Inability to void urine, with paraplegia, was followed by the power of retention, and incessant desire to pass water, but eventually by dribbling incontinence; so that on introducing a catheter, the bladder was found to be empty.

The neck of the bladder may be the seat of *structural* disease, or malformation; occasionally, of disorganization resulting from injury, as from a kick or fall on the perineum, or the operation of lithotomy. In such cases there is no power of retention; the unhappy sufferer has lost, or may never have possessed, command over his bladder, and the sphincter is itself powerless to contract. Then the incontinence is usually a *continual* dribbling, the urine running off from the bladder as fast as it arrives there from the kidneys. This condition, therefore, differs from both the ordinary modes of incontinence, in childhood or adult life. It differs also from frequent micturition; not only in its involuntary character, but in there being no distinct acts of micturition.

The *causes* of incontinence differ according to the period of life at which it occurs, in relation to the state of the bladder. A *child* wets his bed, owing to relaxation of the sphincter, from various causes; general debility, and an apparently hysterical diathesis, or from intestinal irritation, sometimes in consequence of habitual masturbation, or an acid state of the urine. An *adult* is liable to incontinence from the causes of retention; paralysis involving the bladder, atony from overdistension, stricture, enlargement of the prostate, cystitis, stone. In the *female*, hysterical incontinence is not unfrequently met with; but an involuntary dribbling is generally the result of some injury to the urethra, impairing or destroying the action of the sphincter; such as sloughing from pressure in difficult labour, or the bruising effect of instruments in delivery; or from overdilatation of the urethra for the extraction of stone in the bladder.

Treatment.—In *children*, a general tonic plan of treatment is commonly indicated, combined sometimes with sedatives. Thus, the vinum ferri, or the sesquichloride of iron, quinine, strychnia, tincture of cantharides, may severally prove beneficial. Sir H. Thompson speaks highly of the extract of belladonna, commencing, according to the age of the patient, with the sixteenth to the eighth of a grain twice a day. In extremely obstinate cases, he recommends a solution of nitrate of silver, ten grains to the ounce, as an injection to the prostatic portion of the urethra and neck of the bladder. In the female, this remedy is easily applied. The sacro-lumbar region may be subjected to the influence of a cold douche every morning; or to counter-irritation, occasionally, by blistering. Any source of irritation must be removed, as intestinal worms; masturbation, when practised, should be prevented, if possible; and acidity of the urine corrected. The child should not be allowed to lie on his back, for, as Sir Charles Bell first noticed, recumbency favours the tendency to incontinence. But the difficulty is by any contrivance to prevent the supine position being taken by the little patient. Sometimes wetting the bed occurs periodically—early in the night or in the morning. Quinine is specially beneficial as a preventive in such cases. Under this course of treatment the child, who previously had piddled his bed perhaps every night, may at length retain his water; care being taken not to allow the whole night to pass without seeing that the little patient's bladder is voluntarily relieved. After puberty, the child will generally outgrow the complaint. This happy result was obtained in the case of a young gentleman, about whose incontinence I was consulted by the late Mr. J. F. Clarke; the anxious parents fearing that his vesical weakness might portend some generative incapacity. The most troublesome case to deal with, is that of an imbecile or daft child; in whom, I may remark, although the bladder is often incontinent, the genitals may be prematurely developed.

In *adults*, the distended bladder must be relieved by passing a catheter, as occasion requires; and remedial measures should be directed to overcome the causes of incontinence. In cases of an incurable character, a urinal may be worn with great comfort. Various contrivances have been used; one of the best being a vulcanized india-rubber bag, on the inner side of the thigh, attached by a tube to the penis, and provided with a distal tube passing down the leg to the heel of the boot, where, by means of a small concealed stopcock, the urine can be let off (Fig. 8). A patient told me that, wearing this contrivance, he could readily relieve himself over a drainage-grating in a public thoroughfare unperceived by anyone, and, therefore, without offence to public decency.

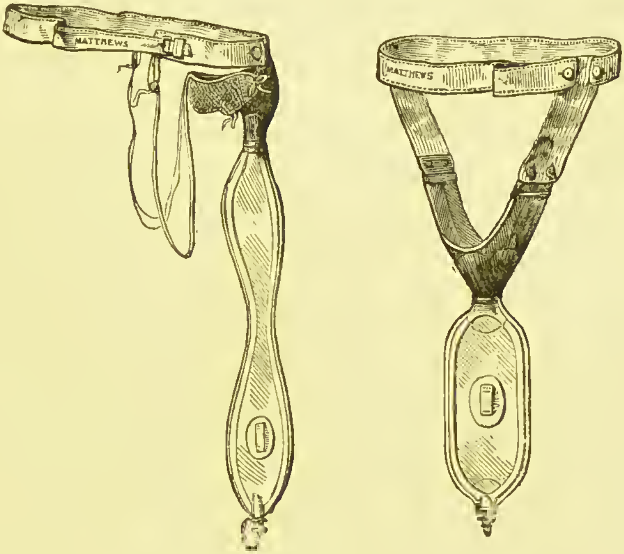

Fig. 8.

The street-urinals of this metropolis are too few and far between for ordinary convenience; and certainly they offer inadequate provision for the more urgent necessities of all those—a very numerous class—who suffer from some affection of the bladder. But perhaps the Board of Works have no such visitings of nature; and Vestries are quite above them.

Retention of Urine from obstruction will be considered in connection with Urethral Diseases.

CHAPTER II.

DISEASES OF THE BLADDER.

In pursuing the order of clinical investigation, we pass from functional disorders to diseases of the bladder—from symptoms to their causes, so far as structural alterations of the organ affected have that relationship—a natural and easy transition, and which has been already anticipated in the course of the previous chapter.

The diseases to which the bladder is subject, are not different in their nature from those of other organs, but they present special and important modifications in their pathology and symptoms, and thence in their treatment. Thus, inflammation, known as Cystitis, acute and chronic, and various Morbid Growths or Tumours, may affect the bladder; and the Malformations of this organ are peculiar; while the Injuries to which it is liable are worthy of some special notice.

Cystitis—*Acute.*—*Structural Condition.*—The seat of inflammation affecting the bladder is primarily the mucous membrane; occasionally, in consequence of the intensity or duration of the process, the sub-cellular tissue and the muscular or middle coat may secondarily become involved; but this inflammation never occurs in the middle and outer or peritoneal investment, independently of the mucous membrane. The portion of this membrane situated about the neck of the bladder, is most commonly and severely affected; extending thence to the whole of the lining membrane. After death, the membrane is found injected and reddened in specks and patches; or it may have assumed a greenish slate-colour, or a chocolate tint, when the inflammatory condition has been of some duration. Occasionally, lymph-effusion takes place on the surface of the mucous membrane; forming shreds or patches of lymph, or even a false membrane slightly adherent to the whole interior of the bladder. Very rarely, this membrane has been known to cause retention of urine, necessitating puncture of the bladder; and I remember the late Dr. Robert Knox to have told me that, in Edinburgh, he had seen a membranous vesical cast of this kind drawn out of the bladder by supra-pubic puncture. In the female, it is sometimes thrown off entire.

Symptoms.—*Acute* inflammation of the bladder is, in my experience, less frequently met with than the chronic form of this disease; but as being often the primary affection, it first merits attention. The patient complains of severe pain and a sense of aching weight in the region of the bladder above the pubes, extending into the urethra and perineum, and even down the thighs; this pain is accompanied by frequent and very urgent micturition,—the urine being expelled at short intervals, in small quantities, and by spasmodic straining efforts to drain off the last drop. Let anyone witness, not to say experience, a paroxysm of this kind, and he will not soon forget it.

These symptoms are those of the irritable bladder, only in an extreme degree. But on placing the hand just above the pubes, the contracted bladder, forming a small, round, and firm tumour, will be found exceeding painful on pressure, or when touched or tilted with the finger through the rectum, or vagina; while the character of the urine also, which is high-coloured and acid, mixed with milky mucus or purulent matter, and perhaps tinged with blood, proclaims an inflamed state of the vesical mucous membrane. When this urine has stood for a few hours in a receptacle, it deposits a whitish, semi-transparent cloud,—somewhat opaque and yellowish, when purulent; or of a brownish tint, when blood-stained. On dipping a spill of paper into this cloudy deposit, it is found to be more or less viscid and tenacious as the mucus or purulent matter prevails. Sometimes the urine is alkaline, and drops a small quantity of brownish adhesive mucus, which clings with more tenacity to the bottom of the vessel.

The constitutional disturbance or inflammatory fever is often severe.

The *source* of pus in the urine,—with reference to whether it proceeds from the bladder, kidneys, or urethra, —is an important question of diagnosis. Purulent urine, as from the bladder, exhibits a diffluent deposit, and which presents, under the microscope, an abundance of pus-cells; when proceeding from the kidneys, the pus-deposit is similar in appearance, but it consists principally of pus-cells in the form of casts from the uriniferous tubules, as symptomatic of suppurative nephritis. Urethral pus is distinguished by the appearance in the urine of threads, consisting of coherent pus-cells, which are thus twirled together, and expelled in the stream by the act of micturition. The distinction between pus and mucus is indefinite; the cells are very similar or identical, but the diffluent or coherent character of the two deposits may differentiate them; except when the urine becomes alkaline from ammonia, which converts the pus into a tenacious, mucoid matter. This, however, is characteristic of *chronic* cystitis.

Various causes may give rise to acute cystitis. Commonly, it is the consequence of inflammation extending from some neighbouring part; retrocedent gonorrhœa, invading the neck of the bladder; or an extension of inflammation from the prostate, rectum, or kidneys. Injuries also may have a similar influence; such as a kick on the perineum or pelvic fracture; but more frequent causes are, operations of lithotrity, rough or prolonged catheterism, injections, or lithotomy; in the female, tedious, or instrumental labours; also the mechanical irritation of a stone or other foreign body in the bladder, the action of the urine itself, from over-acidity, or from distension, when retained and decomposed, as in stricture or prostatic enlargement; the stimulant effect of cantharides, or of some mineral poisons, and strong diuretics. Sometimes exposure to cold has affected the bladder, as I have known to occur from sitting on damp grass at a picnic; and sometimes the disease is a touch of the gout. Any person subject to the chronic form of cystitis is liable to an acute attack.

Cystitis generally commences suddenly, and runs a rapid course; terminating, usually, in resolution,—the symptoms passing off. And even in the stage of purulent secretion, recovery is not uncommon; or the disease may subside into the chronic form; but a fatal issue may occur from suppuration in the wall of the bladder, leading to peritonitis, or between the bladder and rectum, followed by urinary infiltration and pelvic cellulitis, ulceration or sloughing of the mucous membrane taking place in the worst cases. By extension of the vesical inflammation, the ureters and kidneys become involved, the latter being affected either in the form of pyelitis or nephritis. This may be accompanied with dilatation of the ureters and pelvis of the kidneys. But all these backward consequences of cystitis are more commonly found in connection with retention of urine, as from stricture or enlargement of the prostate.

Treatment.—To subdue acute inflammation of the bladder, the plan of treatment will generally consist in derivation, and the administration of alkalies and diluents, to render the urine unirritating, with the influence of opium, to allay pain and spasm. By perfect rest in the recumbent position, the bladder is relieved of the whole weight of the upward column of blood; and this derivation may be aided by warm fomentations to the abdomen, and leeches to the perineum. The bowels should be kept comfortably open by laxative aperients, which in having a derivative action, remove also any intestinal irritation. A dose of calomel in the beginning, may be followed by castor oil or salines; a bedpan being used, so that the patient shall not rise up, and perhaps also take a chill, whenever the bowels are relieved. Diluent drinks, such as barley-water, should be liberally allowed;

and the citrate or nitrate of potash, largely diluted. Thus, the citrate may be taken in doses of a scruple to half a drachm, thrice daily, so as to keep the urine neutralized; taking care, however, not to trouble the bladder by aggravating the frequent micturition. The distressing vesical irritability is, I think, best subdued by opium, in the form of enema or suppository; while the continued influence of opiates, taken internally, tends to allay pain and overcome inflammation. Belladonna, hyoscyamus, and conium have also some reputed efficacy, whether administered by the mouth or per rectum. The combination of a sedative with an alkali is often convenient; and the joint action of hyoscyamus with liquor potassæ may be especially recommended, given perhaps in the form of a diluent drink.

If cystitis be the consequence of *retrocedent* gonorrhœa, the return of urethral discharge should be solicited by warm fomentations to the penis, or by wrapping it in a poultice. Conditions of the *urine* must also be attended to, as special causes of cystitis. When the urine is acid, with a yellowish and diffluent or purulent sediment, calomel and opium—two grains to half a grain, in pill—may be taken twice or three times a day; as originally recommended by Sir B. Brodie. When, as he observes, the urine is alkaline, with the brownish adhesive mucous deposit, colchicum should be given, say fifteen-minim doses of the wine, thrice daily, for three or four days. The same treatment is applicable also in cystitis of a gouty character; but it must be coupled with scrupulous attention to diet. Cystitis resulting from *cantharides*, comes on usually within two or three hours after the dose, or absorption from a blister; although attended with pain in the loins, and bloody urine, the symptoms soon subside, perhaps in from six to twelve hours. Bicarbonate of potash and full doses of hyoscyamus may be given every half hour for three or four hours; and the patient should lie down—as, indeed, he will be sure to do, until the renal and vesical irritation have passed off. If a blister be the cause, it must be removed at once, and the surface thoroughly sponged free of every particle of cantharides.

Chronic Cystitis.—This form of the disease is always attended with muco-purulent matter, of an alkaline character, in the urine; and the mucous membrane of the bladder has become thickened, velvety, and of a dark colour, perhaps encrusted with white phosphatic deposit; the vessels are much congested, and the muscular coat is somewhat hypertrophied. This condition is most marked when the secretion has been abundant, as *catarrh* of the bladder or cystorrhœa.

The same symptoms are presented as in acute cystitis, modified only by the chronic character of the inflammation. The latter is distinguished by the discharge of thick, tenacious, greyish-white, muco-purulent matter, in greater or less abundance, and which gradually falls to the bottom of the vessel in which the urine is collected. This deposit appears as a semi-transparent jelly, something like parboiled white of egg; and on pouring off the urine, it hangs slightly adherent to the vessel, and then slides down suddenly in a lump, or it can be poured out in long tenacious coils, resembling macaroni. This mucous mass may be tinged with blood, and often presents white streaks of phosphate of lime, being insoluble in the alkaline secretion. The urine itself, acid at first, becomes brownish, ammoniacal, and fœtid, as the urea, which consists of carbonate of ammonia with two atoms of water, soon decomposes. This transformation is induced, apparently, by the mucous secretion acting as a ferment upon the retained urine; while the ammoniacally alkaline state of the urine, thus evolved, is itself an irritant to the vesical mucous membrane, and reacts as a cause in maintaining the cystitis. Unlike the fixed alkali—soda or potash—of the mucous secretion, this volatile alkali—ammonia—transforms the pus into ropy mucus or mucoid pus, and precipitates the phosphates of ammonia and magnesia or the triple phosphates, which also characterize the urine of chronic cystitis. In an advanced state of the disease, the constitutional symptoms are those of a typhoid febrile condition; fits of shivering mark the accession of pyæmic infection, the pulse becoming extremely rapid and feeble, the tongue dry and brown, with great prostration and cerebral oppression; or, the suppression of urinary excretion denotes the stealthy supervention of uræmic blood-poisoning, attended with similar symptoms, and low muttering; but, in either case, the end is near at hand. Sometimes, however, neither the pyæmic shudder, nor uræmic wandering, is ominous of the fatal issue. The patient sinks almost suddenly, as if from the shock of injury. Yet one more attack of his old complaint, and the nervous system, shattered by years of suffering, responds no longer to pain; a brief period of serene and deceptive calm might mislead the inexperienced friend or relative to a hope of recovery; but soon the drawn and collapsed features of the worn-down form dispel this illusion; some flickering up of consciousness may afford time for parting recognition, ere the soul seems to catch the first glimpse of that unseen world which lies beyond the horizon of this world of sense.

Causes.—In tracing the history of cystitis, the chronic form of the disease is often found to be a lingering sequence of acute inflammation of the bladder. But persistent inflammation may also have an independent origin, from any cause of long-continued vesical irritation: from a calculus, or other foreign body, including pus or blood in the urine, as depending on kidney disease; or any species of tumour in or adjoining the bladder; hernia, or extroversion of the bladder; neuralgia of the vesical neck; or from the retention and decomposition of urine; as in stricture of the urethra, or enlargement of the prostate, or in spinal paralysis. The latter disease is not only a cause of retention, but an inflammatory state of the vesical mucous membrane supervenes, as the result of impaired nervous influence. The relief of habitual over-distension with atony of the bladder, is apt to induce chronic cystitis; not from the loss of innervation, but of vascular support from compression by the retention of urine.

Treatment.—As in acute cystitis, the indications of treatment comprise: derivation from the bladder, correction of an irritant state of the urine, and the relief of vesical irritability and pain. For the purpose of counter-irritation—not often, in my opinion, of much use—a mustard-poultice or iodine paint may be applied, occasionally, to the supra-pubic region; or a blistering liquid of cantharidine in chloroform to the perineum, when the neck of the bladder, more particularly, is affected. But measures should be more especially directed to arrest the abundant muco-purulent discharge, and to correct the alkaline state of the urine. Pareira brava, uva ursi, and buchu, given with the mineral acids, are more or less efficacious; but I much prefer a concentrated decoction of pareira, with diluted nitro-muriatic acid, in ten or fifteen minim doses, taken three or four times daily. Sir H. Thompson speaks of the triticum repens, or common couch grass, which he introduced some years since, as still maintaining its credit. "For use, boil slowly from two to four ounces in a quart of water until reduced to a pint, the strained liquor to be taken in four doses during the twenty-four hours. The alchemilla arvensis, used as an infusion, one ounce to the pint, 'has proved an admirable remedy in obscure cases.'" Benzoic acid renders alkaline urine acid. Any acid is suitable only when the urine is itself alkaline, rather than when it becomes so by admixture with alkaline mucus in the bladder. Then, alkalies should be administered to correct any acidity of the urine, which otherwise, as an irritant, would maintain the vesical inflammation, and thence the secretion of alkaline mucus. I have found gallic acid, in pill, useful in diminishing the secretion of ropy mucus. In some cases I have known a passive vesical hæmorrhage accompany chronic cystitis, usually in elderly patients; and this hæmorrhagic cystitis has yielded most completely to perchloride of iron. Injections are safe, and highly serviceable, when no acute symptoms are present, especially pain and blood-stained urine. They may be sedative, to quiet the bladder, as tepid water; or decoction of poppies, in quantities of not more than two ounces, and retained for half a minute once a day; or astringent injections, as diluted nitric acid, in the proportion of ten minims, gradually increased to twenty, in two ounces of water. These formulæ were first sanctioned by the experience of Sir B. Brodie. But others may be employed, if not preferably, at least when the former have failed or lost their effect. Thus, Sir H. Thompson advocates the acetate of lead, beginning with one sixth of a grain to the ounce of water; and next to this, the nitrate of silver, a grain to eight ounces of distilled water, and gradually carried up to one grain in the ounce of diluent. Of other injections which have been used, such as solutions of bichloride of mercury or of quinine, my experience does not enable me to offer a definite judgment. Carbolic acid, in a very weak solution, two or three grains to half a pint of water, is said to have a corrective effect on the urine, when fœtid. But I am in the habit of simply washing out the bladder with water at blood-temperature—98° to 100° Fahr. This can be done most effectually by means of the bladder-injecting syringe, and large double-current catheter. The injection had better be limited to three or four ounces, thrown in with only just sufficient pressure to bathe the interior of the sensitive and irritable bladder. By these measures, coupled with tonics and a generous diet, to support the patient through the dread exhaustion of chronic cystitis, we may succeed in overcoming the progress of the disease. This, of course, implies the removal, when possible, of any causative condition. Hence the treatment for stone in the bladder, or a tumour of this organ; and of the various causes of retention, such as stricture, enlarged prostate, paralysis. *Cystotomy* has been practised occasionally for the relief of chronic cystitis; the bladder being opened by an incision as for median lithotomy, and a tube introduced to drain off the urine and muco-purulent secretion; thus to prevent any accumulation in the bladder. Upon the principle of keeping the organ at rest, the diseased state may subside, and with it the exhausting constitutional disturbance. But the operation itself involves a certain amount of risk, and the continued use of a tube, for some time, in the neck of the bladder, is more or less a source of irritation. Originally practised by Sir William Blizard, the operation has more recently been resorted to by Dr. Parker, of New York, Dr. R. Battey, of Georgia, and other American surgeons, with variable results. Cystotomy has afforded temporary relief, or no relief; and cystitis has returned on the closure of the wound.

TUMOURS OR MORBID GROWTHS OF THE BLADDER.—Various species of morbid growths may originate in the walls of the bladder, and project into its cavity, as a distinct tumour, having different forms; presenting either a warty excrescence, a pedunculated or polypoid form, or a broad-based mass, which occupies more or less the whole cavity of the bladder. But the detection of the presence of *a* tumour is more important, practically, than the diagnosis of the species. When, therefore, a patient complains of vesical irritability, of perhaps long duration, and of an almost unremitting, and extremely urgent, character; when also constant pain, and muco-purulent discharge in the urine, would indicate the supervention of cystitis; these *mixed* symptoms would beget the suspicion of some source of irritation within the bladder, possibly a morbid growth; but if, in addition, there have been occasional attacks of retention, partial or complete, and of *hæmaturia* or blood in the urine, to the amount of hæmorrhage, then the nature of the case becomes more evident, and the surgeon proceeds to examine the interior of the bladder with a sound. If, on sounding, he touches a tumour, and such examination provokes a return of hæmorrhage, on withdrawing the instrument, he may be nearly certain that he has found out a vesical morbid growth. But why not absolutely certain as to his judgment? Because the supposed tumour may be a calculus in the bladder. Now, under the touch or stroke of the sound, a morbid-growth tumour is soft and dull—emitting no perceptible sound; a stone is hard, and answers with a click or perhaps ringing .sound; and upon these points of distinction mainly turns the diagnosis. Sometimes both tumour and stone coexist in the same bladder; then, the contrasted characters of the two bodies may be well declared; or the tumour may, at times, conceal or mask the stone. But there is yet possibly an exception to the ground of distinction otherwise; a tumour encrusted with calculous deposit may be met with. Then, indeed, the diagnosis is always difficult, and may be impossible. So here I leave the question for the moment.

Proceeding to consider the various *species* of morbid growths to which the bladder is liable, they may all be comprised under four descriptions: (1) Fibrous growth; (2) Villous or vascular growth; (3) Cancer; encephaloid, scirrhus, epithelial, colloid; (4) Cysts.

Fibrous growth springs from the mucous membrane and submucous tissue, and consists of their elemental structures. Commencing in the form of a circumscribed elevation of the mucous membrane, it resembles a *warty* excrescence, but afterwards enlarges, and projects into a *polypoid* form.

The symptoms are those arising from any cause of vesical irritation, with obstruction perhaps to the free passage of urine; and there is also the presence of a foreign body in the bladder. Simulating stone, careful sounding may show that the situation of this body is not the usual locality of a calculus—in the fundus of the bladder—and the form of the tumour may be peculiar; besides which considerations, the general characters of difference—already mentioned—with reference to the density and sound of a stone, when struck, will determine the diagnosis.

Even an *encrusted* growth may be distinguished by its fixed position, and the impossibility of passing a sound around the tumour, free of the bladder. Yet it must be confessed that the resemblance to an *encysted* calculus is then sufficiently perplexing to perhaps baffle the most careful exploration. When seated at the neck of the bladder, the little tumour having a firm consistence may be easily mistaken for an enlarged middle lobe of the prostate, or a polypoid growth. The diagnosis is practically unimportant; otherwise than that, no attempt at removing the tumour should be made in doubtful cases.

This species of vesical excrescence or polypus occurs mostly in childhood and youth. From an original paper* by Mr. Birkett on this form of growth in the bladder, it appears that it occurred before the age of puberty in six out of ten cases, and may even be met with in an infant a year old. The absence of hæmaturia, or less free hæmorrhage, distinguishes fibrous growth from both the remaining species—villous growth and cancer. But, the disease runs its course in a short period, varying from about three months to a year and a half, and perhaps inevitably to a fatal issue, the patient dying from the consequences of repeated retention of urine and exhaustion.

The *treatment* may always be of a palliative character; to mitigate pain and irritability of the bladder by means of opiates or other sedatives, and the use of suppositories; with occasional catheterism for the relief of retention. But the removal of a vesical polypus can seldom be accomplished with safety, and rarely with success. Civiale succeeded with a lithotrite; and Warner with a ligature—after dilating the urethra, in a female, the tumour being the size of an egg. In like manner, Mr. Berkeley Hill also removed a fibrous polypus from the bladder of a woman, by means of a wire écraseur, the patient making a rapid, complete, and permanent recovery.† Of fifteen cases, however, collected by Dr. Senftleben, in all, the patients died, save one. He therefore suggests supra-pubic cystotomy. More recently,

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* "Med. Chir. Trans.," vol. xli.

† Ibid., vol. lxv.

Sir H. Thompson has proposed perineal section, as by median lithotomy, for exploration of the bladder, and for the removal of a tumour, when found to be practicable. He thus succeeded in twisting off a simply fibroid growth, about the size of a chestnut, from the upper fundus of the bladder, pressure being made above the pubes to bring the growth down. The patient rapidly recovered, and has remained free of urinary symptoms for a period of more than two years.

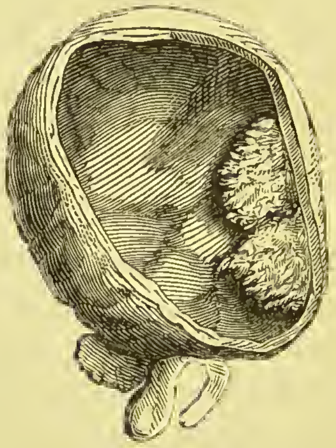

Fig. 9.*

Villous or *vascular* growth springs also from the mucous and submucous tissues; but the cellular structure of this species abounds with large looped capillaries. It presents in the form of innumerable fine villous processes or tufts, branching up from the base in every direction (Fig. 9). When floated in water, this growth appears as a soft, flocculent body, about the size of a large marble, or smaller, according to the state of development. It is situated usually on the base of the bladder. Several such little tumours may coexist, giving to the interior of the bladder a studded villous appearance.

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* Roy. Coll. Surg. Mus., 2005.

No peculiar symptoms characterize this species of growth; either with regard to obstruction, or the presence of a foreign body in the bladder; and, owing to the soft and yielding character of the growth, these symptoms are less marked. But the pain and vesical irritability are aggravated to the highest degree of intensity; and the hæmorrhage is so copious and oft-recurring, that the *bloody* urine bespeaks the greater probability of our having to deal with a vascular growth. Shreds of the tumour sometimes come away in the urine, and, under the microscope, may bear direct structural evidence not to be mistaken.

Palliative measures only are available. The constant hæmorrhage may perhaps be restrained or controlled by astringents; injections of acetate of lead or nitrate of silver, in weak solutions; while gallic acid taken internally may somewhat check the tendency to bleeding. At the same time, the patient's strength must be supported by such tonics as iron and quinine, with nourishing food, in conjunction with opium internally and per rectum; thus to overcome the exhaustion consequent on long-continued suffering, vesical irritability, and draining loss of blood. The villous state of the bladder forbids the introduction of any kind of instrument; sounding will scarcely detect the presence of a growth so soft and flocculent; catheterism aggravates the pain and irritation, and is very apt to provoke an attack of hæmorrhage; while the extraction of a villous tuft would be equally perilous and unsuccessful. But with every care and attention by the surgeon, in doing what may be done, and avoiding improper treatment, the blanched, bloodless appearance, and wasted form of the sufferer, at length tells too plainly of the almost inevitable issue.

Cancer of the bladder is more common than the last-named species of growth. It may originate in the walls of the bladder, springing usually from the base or neck, or extend from the prostate, the rectum, or the uterus, as a form of secondary cancer. The species is generally encephaloid (Fig. 10) when the bladder is the seat of origin, and always of this kind when an outgrowth from the prostate; but as an extension from the rectum or uterus, scirrhus may be met with in the bladder, or epithelial cancer has a uterine origin. Colloid is of rare occurrence; yet, in a remarkable case, I found, after death, the whole cavity of the bladder blocked up with a semi-transparent, greenish-yellow, trembling mass of

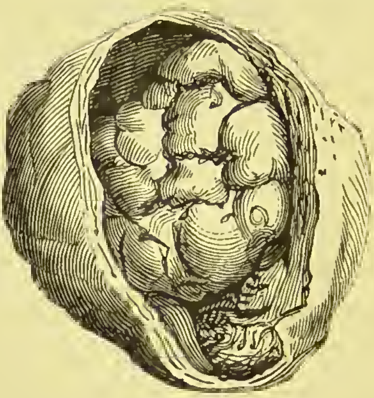

FIG. 10.*

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* Roy. Coll. Sur. Mus., 2003.

jelly; as if the organ were fully distended with urine by complete retention. Similar colloid deposits had taken place in the rectum and uterus, and in most of the abdominal viscera.*

The symptoms of cancer of the bladder are not peculiar; and yet taken singly and collectively, their character can scarcely fail to be misinterpreted. The pain, at first endurable, is referred to the loins and hips, or lower part of the belly, but soon extends into the perineum, shooting along the urethra to the glans penis, down the thighs, and up to the pubes; it increases in severity, as a dull, aching pain, but is rarely lancinating. Vesical irritability is so urgent, that the urine is ejected every few minutes, and as ulceration of the bladder ensues, is expelled with sweating agony. The semen also may be emitted, and the contents of the bowels evacuated, or a prolapsed eversion of the mucous membrane of the anus occur, during this strain of the last few drops of urine. Profuse and gushing hæmorrhage often accompanies or follows the act of micturition; or the urine may be bloody, alkaline, purulent, and fœtid. All these suspicious symptoms are corroborated on finding a tumour in, or involving the base of the bladder, when tilted up with the finger per rectum, and differing, more or less, in consistence, size, shape, and position, from enlargement of the prostate; or by the discovery of a tumour at the lower part of the abdomen, in the region of the bladder. Sounding will also detect the presence of a tumour, emitting a dull sound, as distinguished from the click of a stone in the bladder. But is such tumour malignant or benign? Constitutional symptoms cannot, I think, decide this question; for the so-called *cachexia* of cancer is rarely present, even at an advanced stage of this disease, as affecting the bladder. The patient's general health and aspect is merely that of a person worn down from pain, sleeplessness, and loss of blood. But the general severity of the bladder symptoms may receive additional significance by the detection of cancer-cells in the urine, as revealed by the microscope. Yet the resemblance of cancer-cells to the rudimentary form of vesical epithelium, will render this evidence equivocal; unless, indeed, a mass, or an infiltrated papilla, can be brought to light. The mere amount of hæmorrhage affords no indication as to the nature of the tumour; for a villous growth will bleed even more profusely than an encephaloid cancer. Nor does the condition of the blood passed, as pure and perhaps coagulated, supply any further evidence than that it probably proceeds from the bladder. In a later stage of the disease, enlargement of the glands in the iliac regions confirms the diagnosis; and the tumour may present in the groin, or there may be feculent urine, the tumour having ulcerated into some portion of intestine. The age and sex of the patient should also be taken into account. Thus, scirrhus is more common in men, and between forty-five and sixty years is the most liable period in life. *Calculus* sometimes coexists with cancer of the bladder, especially with the encephaloid species; and here sounding may discover both the presence of a stone, and the nature of the tumour, by the copious hæmorrhage which follows exploration with the instrument.

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* "Principles of Surgery." By the Author. Introductory Elements of Pathological Anatomy, p. 55.

Cancer of the bladder admits of no curative treatment. But the anæmic exhaustion can be met, and life prolonged by the judicious administration of a supporting diet and blood-restoring tonics; the wearing-down suffering can be relieved, and the tormenting vesical irritability can be lulled by opiates and suppositories; and the resources of experience may yet ease the way, as the plough of pain nears the end of the furrow. Retention must be relieved by careful catheterism, with an elastic instrument.

Cysts are sometimes met with, in the walls, or in the cavity of the bladder. As new-formations, they must be distinguished from the sacculi produced by the habitual retention of urine from stone or stricture. True cysts are sometimes *dermoid*, containing teeth and hair. These formations have probably entered by ulceration through the walls of the bladder. Any vesical cyst may become the nucleus of calculous deposit; or some of its contents may be discharged in the passage of urine. Hydatid cysts have also been found in the bladder.

The *diagnosis* of a vesical cyst must always be obscure, unless the escape of its contents per urethram should offer the opportunity for inspection or microscopic examination.

Tubercle of the bladder is a most serious affection, but happily of very rare occurrence. As part of a constitutional disease, tubercular deposit takes place also in other organs, and of the genito-urinary system especially; the prostate and kidneys, or the testis and vas deferens. In females, the uterus is sometimes previously affected. In the walls of the bladder, this deposit appears in the form of small granulations, seated in the mucous coat; and more often at the base or neck of the bladder. These points may coalesce, but continue in a chronic state for a long period.

This condition gives rise to no peculiar symptoms; and the diagnosis is determined chiefly by negative considerations. Severe pain and extreme irritability of the bladder, there may be; but these symptoms are common to other diseases, as the formation of a morbid growth; yet the absence of obstruction to micturition, and of hæmorrhage in any quantity,—the failure to discover a tumour or stone, will probably lead our clinical examination from the bladder to other organs, and thence to the constitutional symptoms of tuberculosis.

The progressive emaciation, taken also in conjunction with the age of the patient—usually early or mid life—afford additional evidence as to the nature of the case. The symptoms of chronic cystitis are associated.

Softening of the tubercular matter at length ensues, and the mucous membrane gives way, presenting an ulcer of variable size; which has a ragged, undermined margin, infiltrated with the deposit. Tubercular matter is now discharged in the urine, which may be recognised by the eye, or detected by the microscope. Ulceration sometimes extends so as to destroy nearly the whole surface of mucous membrane; and then a very large, ragged ulcer is found after death. Rarely, perforation takes place, and extravasation of urine.

Treatment must be directed to the constitutional disease; although the supervention of chronic cystitis will also engage the surgeon's attention. But the prognosis is very unpropitious.

HÆMATURIA.—Blood in the urine, or simply bloody urine, is a *symptom* only, of which disease in some part of the urinary organs is the cause. The quantity of blood discharged varies; a small proportion, not perceptible perhaps until submitted to microscopic inspection; or an amount which may be so large as to constitute the greater portion of the fluid passed.

Any admixture of blood and urine can hardly fail to be recognised by differences in the *colour* of the urine. A small quantity of blood gives to the urine a brownish or smoky tint, and deposits as a reddish-brown sediment. With a larger quantity of blood, the urine has a dark brown, muddy colour, like chocolate; and a red sediment falls down, adhering to the bottom of the vessel. When nearly pure blood is passed, the urine appears as such; and retains nearly the same appearance on standing. On pouring a suspected sample of bloody urine into a test-tube, the smoky or darker chocolate tint is even more clearly seen; heat coagulates the blood into a brownish-grey deposit; and a drop of the urine under the microscope exhibits the characteristic red blood-discs. Both these tests, and especially the latter, will declare the presence of blood in the urine; and thus distinguish hæmaturia from simply dark reddish-coloured urine, arising from other causes; the presence of bile, rhubarb, or other colouring matters, or the mere concentration of urinary secretion.

Having found blood in the urine, what may be the *source* of that blood, or the seat of the disease? The blood may possibly proceed from any part of the whole urinary system—from the kidney, the ureter, the bladder, the prostate, the urethra. But again turning our attention to the state of the urine, as discharged; the *admixture* of blood, more or less completely, presents certain appearances which may guide our judgment respecting this most important question. When the hæmaturia is renal, the urine will be uniformly mixed with the blood, and perhaps casts of the uriniferous tubules; when it is vesical or prostatic, the first portion of urine that is passed or drawn off by the catheter, will be pale and less bloody than the last, and at the termination of the stream, pure blood only may escape; when proceeding from the urethra, the blood may be mixed, but more often unmixed, with urine; it is passed also in the form of worm-like clots or casts of the urethral canal, and independently of micturition.

Many and diverse causes give rise to bloody urine, comprising:—diseases of the kidney, acute and chronic; injury, as blows or strains in the loins; calculus in any part of the urinary tract,—whether in the kidney, ureter, bladder, prostate, or urethra; violent diuretics, as turpentine or cantharides; cystitis; varicose vesical veins, occasionally; prostatic disease; cancer of any part of the urinary organs; villous tumour of the bladder; prostatic disease; stricture of the urethra, urethral chancre, chordee; strong injections; the hæmorrhagic diathesis; certain blood diseases, as typhoid fever, or purpura; and vicarious hæmorrhage from the bladder is sometimes the source of blood in the urine.

Treatment.—The cause of hæmaturia,— the disease whence the blood emanates,—must of course be taken into consideration with the view to treatment, in each particular case. But certain general directions should always be observed; namely, rest, in the recumbent position, and the administration of astringents. Of the astringents which may be taken internally, gallic acid is, I think, most generally available; but other resources offer, in the form of the mineral acids, acetate of lead and opium in pill, and other styptics of known repute. When the hæmorrhage proceeds from the bladder, oil of turpentine is specially efficacious; so also I have found the tincture of perchloride of iron; and cold may be applied to the hypogastric region, the perineum, or within the bladder by injection. But I am in favour of ice-cold water enemata, as a general rule of treatment in these cases. The management of the blood collected in the bladder, is a question respecting which different opinions are held. The coagulum may be broken up and removed. A full-sized catheter is introduced into the bladder, and a syringe being applied, the blood is withdrawn by suction; or the bladder can be washed out through a large-eyed double-current catheter (Fig. 11), using cold water for this purpose. After either method of evacuating the bladder,—and the latter method is preferable,—I am in the habit of using a weak acid injection, to stop the recurrence of hæmorrhage. Generally, however, any disturbance of the clot would seem to be unnecessary and prejudicial. Its removal is apt to re-open the vessels and renew the bleeding; while the solvent action of the urine itself will most safely and effectually

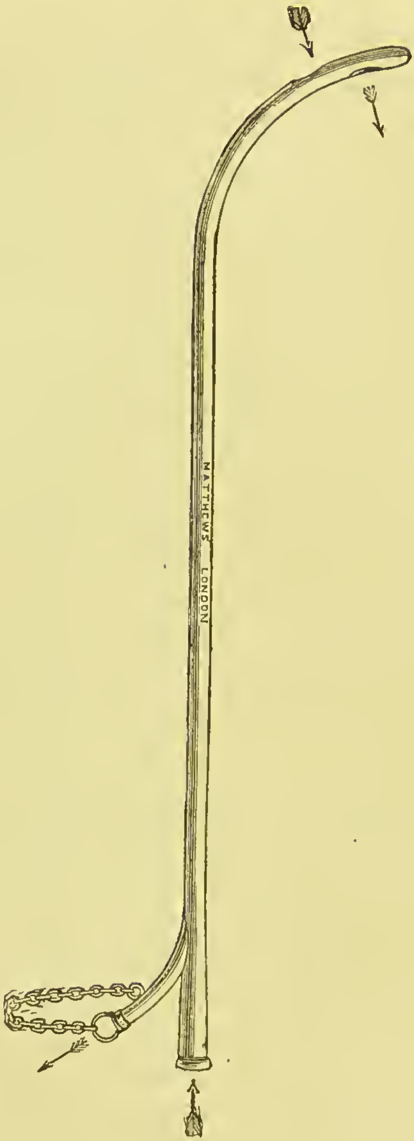

Fig. 11.

bring away the blood. The urgent desire to micturate may be controlled by the moderate influence of opium; and retention of urine can be relieved by gentle catheterism, to prevent any distension of the bladder.

MALFORMATIONS.—The bladder is liable to various congenital malformations, which may be either of three kinds:—(1) Extroversion of the bladder, arising from a congenital absence of the anterior wall of this organ, with an equal deficiency of the anterior wall of the abdomen, thus exposing the posterior wall of the bladder as a prominent projection; (2) Absence of the bladder, with certain abnormal deviations of the ureters,—by their direct communication with the urethra, the rectum, or the vagina; (3) Bipartite bladder, or the co-existence of two or more bladders.

Extroversion of the bladder is usually connected with absence of the pubic symphysis, leaving an interval or gap, which may be bridged across by a fibrous band of union between the pubic bones, from which the recti muscles diverge in the lower part of the abdomen. The anterior wall of the bladder being wanting, the posterior wall bulges forwards in the space between the muscles, and may even form a convex projection, owing to the downward pressure of the abdominal viscera. The exposed mucous surface of the bladder has a bright red, vascular appearance, and presents the orifices of the two ureters, as prominent papillæ, about an inch apart. From these orifices, the urine distils and trickles downwards, perpetually moistening the mucous surface; but in some cases, the ureters having become dilated, the urine is retained in them, and ejected in jetting streamlets occasionally. Below the extroverted bladder, a short, imperfect penis depends, which is flattened and cleft above, as an epispadias,—showing the floor of the urethra, even as far back as the prostatic sinus and crista galli, with the openings of the ejaculatory ducts. The prostate itself may be absent, but more often is rudimentary, and corresponds to the pubic gap. Below the penis, there is a scrotal pouch of integument, containing the testicles, of small size, with usually some hernial protrusion of the bowels beneath the extroverted bladder.

Both sexes are liable to this malformation, but it occurs far more commonly in the male. In the female the external genitals are also imperfectly developed; the clitoris is usually split, and the labia diverge upwards to the integument adjoining the extroverted bladder.

Yet the sexual function may be performed,—*proh pudor;* and in at least two instances, pregnancy has followed, and safe parturition.

In both sexes, the exposed mucous membrane of the bladder is very sensitive, and readily bleeds, while the continual distillation of urine, rendered alkaline and decomposing from contact with the mucus of the inflamed bladder, thus produces excoriation of the parts beneath; and pervading the unhappy sufferer with a constant odour of stale and ammoniacal urine, compels him, or her, to lead a life of seclusion. This wretched state is rendered worse, by the absence, in most cases, of the pubic symphysis; for then, the pelvis being loosened, and the hips widened, the person thus afflicted can only shuffle about from chair to chair.

Treatment.—It might be supposed that a malformation so sad as an open and protruding bladder, would long since have engaged the attention of the true surgeon, who is always full of compassion, for devising means of relief, be the object ever so loathsome. 'Tis there that the heart most expands and palpitates with pleasure; even as the Great Master often selected the leprous outcast for the cleansing operation of His mercy. But some years since, the subjects of extroverted bladder were almost unknown to the humble craftsmen of Surgery. As a student at University College Hospital, I remember only one such case; a poor lad who was shown as a natural or unnatural curiosity, with his little bag for alms-giving; and who went the round of the Metropolitan Hospitals. As surgical attention has been directed to such cases, patients have presented themselves more frequently at hospitals, and in private practice. *Mechanical* contrivances of various kinds have been devised with the view of forming an artificial abdominal wall over the bladder, and to catch the urine as it flows; thus preventing excoriation and the urinous odour. An india-rubber bag, or urinal, secured in position, may answer this purpose. But any artificial substitute requires great nicety of fit, and capability of adjustment to the various positions of the body. Accordingly, the handmaid of Surgery—mechanism—has here given place to *plastic* operations, for the purpose of restoring the deficient abdominal wall and completing, as it were, the urinary bladder. An ingenious procedure of this kind was originally performed by M. Adolphe Richard, in October, 1853; it was founded on one performed by M. Nélaton, for epispadias, in 1852. A few years afterwards—1859—Pancoast, of Philadelphia, introduced the use of two reversed flaps of integument, taken from the sides of the bladder, and turned with the skin surface towards the bladder. In the same year, Dr. Daniel Ayres, of New York, operated on the same principle; but the skin around the margin of the exposed bladder was dissected up, and brought together by sutures over the raw surface of the reflected flaps. Into this country, an important modification of the operation has since been introduced by Mr. T. Holmes; the reversed and superimposed flaps are taken from the groins, at the sides of the bladder, whereby a better supply of nourishment is provided, from the recurrent branches of the common femoral artery, for primary union to take place. Mr. John Wood has completed the operation, in all its details, and has been the most successful operator.

The *operation* now consists of two stages; the first to effect the closure of the upper part of the bladder; the second, after the interval of about a month, to close in the lower part, and to form a prepuce and complete the urethra.

Closure of the bladder may be accomplished by reflecting two triangular flaps of skin, one on each side of the exposed bladder, with their bases downwards, and attached to the skin of the groin at Poupart's ligament. The apex of each flap meets the other at the median line above the extroverted bladder, so that the raw surfaces exposed by lifting them are continuous at that point. The inner edges of the flaps are made close up to the bladder, and are brought together in the median line, and united by interrupted wire sutures. The penis may then be fastened down to the scrotum by a silver wire suture passed through the frænum, to allow a free escape of urine. Then the angles of the groin and umbilical incisions are to be united by wire sutures.

In other cases, the bladder may be closed by two lateral flaps, as in the preceding method; but one being reversed with the integumental surface towards the mucous membrane, and the other superimposed upon the raw surface of the former.

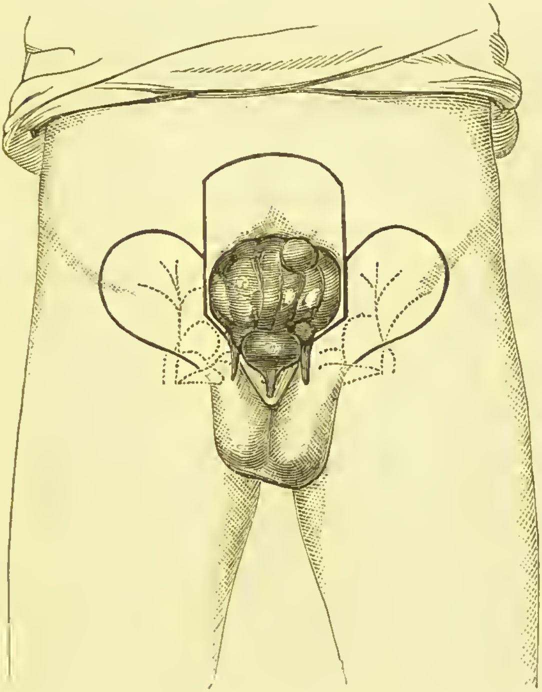

FIG. 12.

But the operation now generally practised consists in making three flaps; an umbilical, of a somewhat square shape (Fig. 12), and of large size, embracing the whole width of the exposed bladder, and vertically rather longer, this flap being reversed towards the mucous membrane; the two lateral groin flaps are of pyriform shape, with the peduncle directed towards the thigh and scrotum, and these flaps are superimposed upon the raw surface of the reversed umbilical flap, and meet in the middle line. The side-flaps, thus adjusted, are secured by three or four harelip-pins, transfixing the whole thickness of the flaps, and passing more deeply through a portion, but not the entire thickness of the umbilical flap (Fig. 13). The surfaces exposed, by raising the three transplanted flaps on either side and above the bladder, are then to be closed in, by uniting the margins of the wounds with harelip-pins; forming a vertical line in the upper or umbilical wound, and two inclining horizontal lines in the groin wounds (see Fig. 13). Strips of plaster also should be placed in the intervals of the sutures, as an additional support to prevent any traction on the

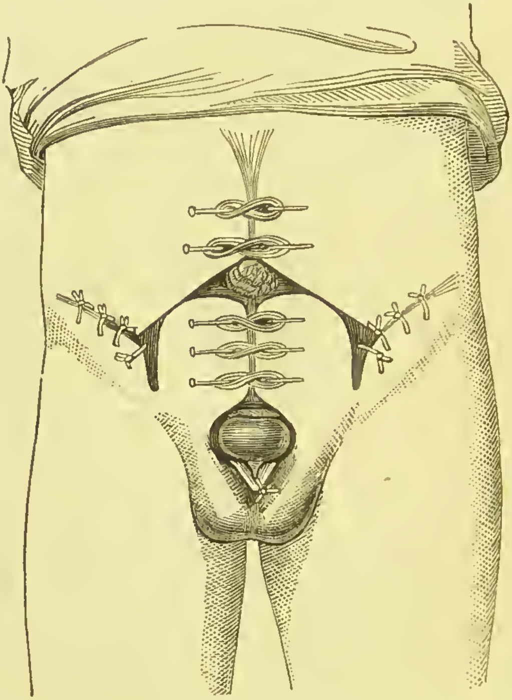

FIG. 13.

integument. These strips should be of sufficient length, and run transversely and obliquely across the abdomen and groins, to draw the integuments towards the middle line, thus to prevent the slightest strain upon the sutures, and allow the lines of union to lie in quite easy apposition. For this purpose, also, the patient must be placed in bed in the sitting posture, and with his knees drawn up and tied together.

Sometimes the operation is *complicated* by hernial protrusion, in some situation or another; and then the surgeon will have to exercise all his ingenuity in devising the shape of the flaps so as to leave that weakened part supported by integument, and yet to cover the exposed surface of vesical mucous membrane.

Completion of the urethra and the formation of a prepuce—according to Wood's operation—"consists, in raising the whole front of the scrotum, together with the skin covering the lower side of the penis—going deep enough to include the muscular layer of the dartos—so that these tissues form a sort of bridge of skin connected with the groin on both sides. This is then lifted over the penis, which the great extensibility of the parts permits easily to be done, and placed upon a bed or raw surface, prepared for its lodgment by turning down a collar or flap from the arched border of the bladder-covering above (Fig. 14), and from the sides of the urethra and penis below, as far forwards as the glans. A continuous thin wire suture holds the deeper or reversed flaps together, and a single line of interrupted suture connects the transplanted scrotal structures to the border of the bladder-covering (Fig. 15). The gap in the scrotal wall is afterwards easily closed in over the testicles by the great extensibility of the hinder part of the bag, which is left intact; the margins of the wound being brought together vertically by thickish wire sutures that will not easily cut out."

As to the *difficulties* of these plastic operations, Mr. Wood finds, that in the first stage—closure of the bladder—the chief difficulty arises from the hernia-like protrusion of the hinder wall of the exposed bladder by the action of the abdominal walls upon the contained viscera. In the second stage—that of forming the new prepuce and completing the urethra—difficulty is due to the occurrence of erections in the imperfect penis, excited

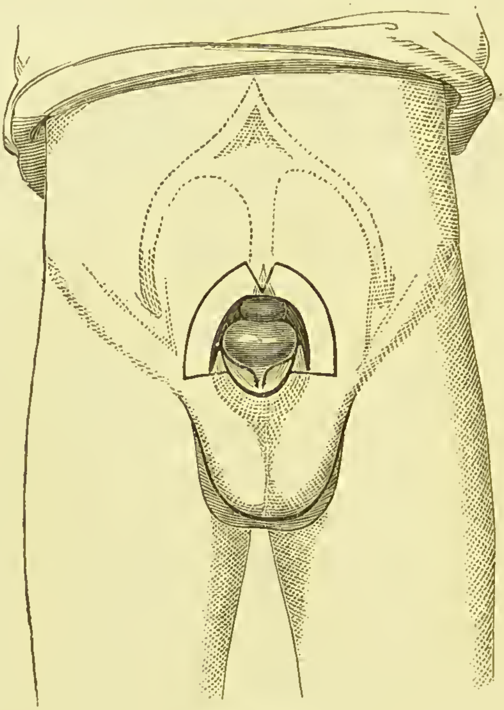

FIG. 14.

perhaps by irritation of the sutures; thus displacing the united parts, or rupturing the newly-formed adhesions, before sufficiently secure to resist tension.

After-treatment.—The former difficulty referred to, is best obviated by a proper *position* of the patient after operation: a sitting posture with the knees drawn up, tied together, and placed over a high bolster. This relaxes the abdominal and pelvic muscles connected with Poupart's ligament completely, and also allows the urine to drain off by gravitation from the raw and adhering surfaces. To prevent any strain upon the flaps during defecation, it may be desirable to keep the bowels confined under the influence of opium for the first few

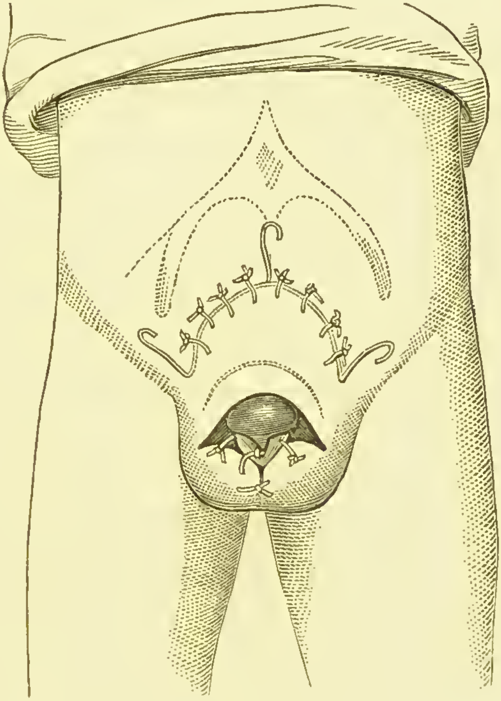

FIG. 15.

days, as well as to have them freely open before the operation. A large sponge is placed against the perineum to absorb the urine as it drains away from the supra-penal aperture. Erections are most effectually controlled by *cold* applications, as by irrigation or ice-bags. Removal of the pins should be regulated by the course of the union. Probably, in about a week some of them may be withdrawn, leaving the support of plaster strips as may be necessary. At the end of four or five weeks, union will usually have been completed. Sometimes the growth of hairs on the bladder aspect of the umbilical flap is a source of irritation and delay. If the hairs can be got at, they may be picked out with forceps. Extreme cleanliness must be observed throughout the treatment by gently syringing the margin of the flaps, and especially around the bladder, where phosphatic deposit is apt to collect, which may be dissolved by injection with weak acid solution.

Results of Operation. — Considerable success has attended this operative procedure for the plastic repair of extroverted bladder. Richard's case was unsuccessful; death ensuing in nine days from peritonitis. But Ayres's two cases were both successful. So also was another by M. Michel (1868), in the person of a male infant, fourteen months old. Mr. Wood records eight cases of operation ("Med. Chir. Trans.," 1869), in none of which was there the slightest approach to peritonitis; and all recovered, except the first, which terminated fatally, but not in consequence of the operation. The ultimate success of operation, in curing or relieving the malformation, has been variable; sometimes a perfect result, or a complete failure, sometimes a greatly improved condition. The causes of failure have been sloughing of the flaps; whether from their too limited extent, or their subsequent tension, as from the want of support, or the strain put upon them in the act of defecation. Sometimes the flaps may not have partly perished, but they become atrophied, owing to deficient blood-supply from not placing the groin-peduncles so as to contain the nutrient branches of the femoral artery. Peritonitis has seemed to arise from dissecting up the umbilical flap too deeply or below the fascia; especially where the parietes are thinnest, just above the extruded bladder.

Displacements.—Under this title I propose to notice briefly two forms of Displacement, which as relating to the Bladder are occasionally met with in practice; Prolapsus, and Hernia.

Prolapsus may occur in females, the bladder falling down with the anterior wall of the vagina; in the form of a rounded swelling within the labia, or perhaps appearing externally between the thighs. This tumour is soft and fluctuating to the touch, especially when pressure is made above the pubes; and the transverse rugæ of the vagina may be seen, unless the swelling be very tense. The compressible character, and the size of this vaginal swelling, will vary with the more or less distended state of the bladder; and after micturition, only a lax condition of the vaginal wall may remain. Passing the finger on to behind the tumour, the os uteri may be felt, having a direction downwards and backwards; and this uterine retroversion arising from the bulging tension of the vaginal wall, in front, there can be no doubt that the case is not one of prolapsus uteri, and which is a more common affection. Prolapsus of the bladder is attended with some bearing-down sensation—stretching even from the navel, when the bladder is full; and constant vesical irritability urges to frequent and straining micturition; but with incomplete effect, as the fundus of the bladder still remains full; and while repeated efforts gradually increase the prolapsus, partial retention of urine at length provokes chronic cystitis. Surgical relief is sought sooner or later, for the bladder is not quiet in any state; whether moderately full or partly emptied. A catheter is introduced, and then—in addition to the vaginal tumour and vesical symptoms—the surgeon can plainly feel the point of the instrument in the vagina, when turned down into the fundus of the bladder; and from which receptacle a quantity of urine may be drawn off, below the level that the patient could expel. By tilting up the vaginal wall with the fingers, the bladder is readily emptied; and this natural mode of relief, aided by an inclined position forwards, the patient may herself have learnt by experience.

The *cause* of this prolapsed state of the bladder is soon discovered. The patient has a large, relaxed *vagina;* which may be the result of anything that has impaired the natural tone of the passage. Commonly arising from repeated pregnancy, and tedious or difficult labour, this state of the parts is found mostly in women who have borne many children, and in rapid succession. Sometimes also in women who are weakly, and subject to leucorrhœa, the vagina is naturally so lax that prolapsus of the bladder seems to be ever impending. But a naturally lax *perineum,* which readily yields under any straining effort, is, so far as I have observed, rather a protective support against the descent of the bladder —or, indeed, of the uterus.

Prolapsus of the bladder, through the urethra, in the female, is a very rare form of displacement, yet practically important, as the projection may be mistaken for a polypoid urethral growth. The late Mr. Crosse, senr., met with a remarkable case in the person of a child, under three years of age; a tumour projecting from the external urinary meatus was the size and shape of a walnut, and having a bright scarlet colour, with a granular surface, it looked like a vascular growth. As such, the medical attendant would have removed by ligature that which proved to be a knuckle of the bladder. Mr. Crosse returned it up the dilated urethra; and although the prolapsus had been of considerable duration, it did not re-appear.

Hernia of the bladder, alias *Cystocele,* is another displacement of very rare occurrence. The protrusion may take place in either of the ordinary situations, as *inguinal* or *femoral* hernia; but it has been met with also as a *perineal,* an *obturator,* or an *ischiatic* hernia. In the female, femoral and vaginal cystocele occur, although rarely. A tumour of a softened compressible character appears, say in the groin, and descends into the scrotum; thus resembling an intestinal protrusion— an *enterocele.* But certain peculiar and distinctive symptoms may be observed. The size of this swelling is scarcely affected by coughing, and which gives only a slight impulse, nor by the position of the patient, standing up or lying down; the swelling varies in size as the bladder is emptied, and fills again. On compressing the tumour during the act of micturition, or with a catheter in the bladder, the *quasi* intestinal protrusion subsides; but it returns with the re-accumulation of urine. The unaided act of micturition may not reduce the swelling, for the protruded portion of the bladder still remains full of urine; and this partial retention is attended with incessant vesical irritability, and frequent desire to pass water—another symptom which distinguishes cystocele from intestinal hernia. A *scrotal* cystocele may simulate hydrocele—both are fluctuating tumours; but hydrocele is irreducible, except when congenital, and then the transparency of the distended tunica vaginalis *may* contrast with the opacity of a protruded bladder.

Vesical hernia seems to originate in a relaxed and enlarged state of the bladder—an atonic condition, coupled with the retention of urine. The distended bladder yields laterally, more readily than in any other direction, and thus reaching the internal abdominal ring, it may partly protrude through the inguinal canal. At first, there is no peritoneal investment—no sac; but when the fundus of the bladder descends, the peritoneal covering presents a sac. Sometimes, an ordinary intestinal and omental hernia co-exists, and this protrusion descends in front of the cystic, behind which lies the spermatic cord. In some cases, the protruded portion of bladder has contained not only urine, but also one or more calculi—formed apparently in consequence of retention. With any symptoms of stone, sounding then, of course, will not detect the calculus. When situated in the groin—as a cystic bubonocele, the stone has been mistaken for a bubo; an odd mistake, considering all the different circumstances of the two cases.

The *treatment* of cystocele is simply that of hernia; the protrusion should be reduced, and kept up by a truss; or when irreducible, a suspensory bag must be worn, and the herniated portion of bladder should be compressed to empty it, during micturition.

In the event of an operation, owing to strangulation, the surgeon will remember the peculiarities of the hernia with which he has to deal:—the absence, usually, of a peritoneal sac to the bladder; and the possible co-existence of an intestinal hernia, with a sac, overlaying the cystocele, which may have become thickened and otherwise changed. Should the vesical protrusion contain a stone, this should be returned into the cavity of the bladder; and afterwards removed by lithotomy or lithotrity. But a stone has been extracted by direct incision into the protruded portion of bladder, and without any unfavourable consequences.

Congenital hernia of the bladder is occasionally met with, as depending on the absence of the symphysis pubis; a similar defect to that which co-exists with extroversion of the bladder.

Injuries.—The bladder, lodged within the bony walls of the pelvis, is less liable than many other organs to external injury, as wounds or rupture, and displacements; and only occasionally to the intrusion of foreign bodies from without, through the urethra or by gun-shot penetration: but it is very commonly the receptacle of urinary concretions or calculi,—which from both a clinical and surgical point of view constitutes a subject of such interest and importance, that I shall devote the next chapter to its special consideration.

Laceration of the bladder occurs not unfrequently with fracture of the pelvis, this additional injury being a most serious complication, in consequence of the extravasation of urine. An open wound, as by a bullet, may allow the urine to escape freely, externally; and recovery has then been known to ensue. Several such cases are related by Guthrie and by Thomson as having occurred at the battle of Waterloo.

Rupture of the bladder is also not very uncommon, as the result of blows, kicks, or contusions on the lower part of the abdomen, especially when the bladder is fully distended and rises above the pubes in contact with the abdominal wall. Thus, this accident may happen from a fall in wrestling, the uppermost man coming down upon his antagonist, or from running against a post in the dark, an instance of which Liston relates. In that case, a large calculus, which nearly occupied the bladder, was shattered into fragments by the concussion. Atrophy of the bladder would predispose to laceration; and thus from paralysis, the walls of the organ becoming softened and attenuated, are liable to be perforated by the careless manipulation of an instrument, or compression of the abdomen may produce rupture.

The *symptoms* of a lacerated or ruptured bladder can scarcely fail to attract attention. The patient is seized with a sudden and intense burning pain in the lower part of the belly, with immediate collapse, and inability to pass water, or only a little bloody urine comes away through the urethra, while the abdomen becomes tense; all these symptoms having arisen from some such injury as we have already noticed. On introducing a catheter, the bladder is found to be empty, or a small quantity of bloody urine is drawn off. If the instrument pass through a rent into the peritoneal cavity, more bloody urine may be drawn off, the stream ebbing and flowing with the respiratory movements. In gun-shot injury implicating the bladder, the urine may perhaps be seen to escape through the track of the wound. Extravasation of urine is more or less perilous, according to whether it takes place into the peritoneal cavity or into the cellular tissue of the pelvis; this difference depending on the situation of the rent in the bladder, as above or below the reflexion of the peritoneum. In the one case, fatal peritonitis speedily ensues ; in the other, diffuse cellulitis, and a less rapid and surely fatal termination.

Treatment must be directed to the immediate prevention of yet further extravasation of urine. A full-sized gum-elastic catheter should be passed into the bladder, and retained by tapes; that the urine may dribble away as fast as it descends into the bladder. Any appearance of urinary infiltration presenting externally, must be at once met by free incisions, so that the noxious fluid shall escape, and sloughs also as they form. The lateral operation, as for stone, affords a more free drain to the urine; and this procedure, due to Dr.

Walker, of Boston, has been practised with success—at least, when the vesical laceration was outside the peritoneum. When the peritoneal pouch behind the bladder is the seat of extravasation, as indicated by its fulness and fluctuation, the urine should be drawn off dependently, by puncture, with a long trocar and cannula, through the lateral incision. In a case of vesical rupture, involving the peritoneum, Mr. Erskine Mason having thus evacuated the urine, the patient recovered. This prompt interference may succeed in circumscribing the infiltration, and in time for a barrier of lymph to be thrown out, ere the supervention of blood-poisoning. Peritonitis is less under control; for although the catheter commands the bladder, the urine already extravasated and imprisoned within the peritoneal cavity, still maintains the inflammation. This also will be reduced by puncture of the cul-de-sac through the lateral operation. Cystotomy, as thus performed, is a more promising method of treatment than abdominal section above the pubes, for the evacuation of urine from the peritoneal cavity, when a catheter cannot be passed thence through the urethra, and the cavity washed out. Dr. Thorp seems to have succeeded in the latter way; and in a case by Dr. Walter, supra-pubic cystotomy also proved successful. Yet when this procedure was combined with closure of the rent in the bladder, by continuous catgut suture, the result was unsuccessful in the hands of Mr. Christopher Heath, and in a previous case also, by Mr. Willett.* The general treatment consists in the watched administration of opium and stimulants, with whatever nourishing food the stomach will accept, to sustain life through the long course of exhaustion.

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* "Med. Chir. Trans.," vol. lxii.

Rupture of the ureter is a rare kind of injury, but it has been known to occur from external violence, and recovery is not altogether hopeless. In a case recorded by Mr. Stanley, a large collection of urine formed around the rent in the ureter, as a circumscribed and fluctuating swelling, which was repeatedly tapped. Ruptured pelvis of the ureter, in another case, led to the formation of a similar cystic collection of urine behind the peritoneum; and no less than six pints were drawn off, at one sitting. But the patient died about ten weeks after the accident.

Foreign Bodies.—Various foreign bodies, such as portions of catheters, bits of pencil or tobacco-pipe, glass, or wax, a hair-pin, and all sorts of odd things, too numerous to mention, are occasionally thrust into the bladder through the urethra. Catheters, whether metallic or old elastic, which have become brittle, are apt to break in the curve or near the eye, while using the instrument. Both sexes have indulged in such practice, whether from some feeling of idle curiosity or morbid propensity. Any substance thus introduced is usually of some length, and lying perhaps across the bladder, is rarely expelled in passing water; it must, therefore, be extracted surgically. This may sometimes be accomplished with a lithotrite, by catching the body in its long axis, or by crushing it, as a stone; but when the substance is soft or brittle, it is better to have recourse to the operation of lithotomy, rather than perchance leave a portion or fragment behind in the bladder. Knowing the size and shape of the foreign body, the median operation can be more frequently selected. But no operative procedure need be taken immediately, unless bladder-symptoms are urgent; for sometimes the foreign intruder is ejected through the urethra, and when least expected, even more easily than it entered. Having failed to extract a hair-pin from the bladder of a young woman,—after crushing the calculus-concretion around it, and fully dilating the urethra, the pin, thus relieved, worked its way out on a favourable opportunity. The male urethra is, of course, a less convenient channel for the natural discharge of any substance from the bladder.

Bullets, bits of clothing, or other bodies are sometimes lodged in the bladder by gun-shot wound, implicating this organ. Any such body must be removed as circumstances permit. Mr. Dixon has collected fifteen cases where the ball had entered the bladder, either in the first instance, or in consequence of abscess and ulceration; and in ten of these cases, the ball was extracted by the operation of lithotomy, with successful results. Of the remaining five cases, the issue is not recorded. Foreign bodies impacted in the rectum occasionally find their way by ulceration into the bladder.

Whatever may be the kind of foreign body in the bladder, it soon becomes encrusted with calculous deposit; and by thus increasing the difficulty of its extraction, while as a persistent source of irritation, chronic cystitis supervenes, the result of any operative procedure may be unsuccessful.

In the *female*, foreign bodies can be removed more readily from the bladder, owing to the urethra being of larger size and more dilatable, while the shorter extent and straighter course of the passage also facilitates extraction.

Worms of various species have, in rare instances, been discharged from the urinary bladder. How they get in and how they creep out, is part of their natural history. The ascaris lumbricoides or round worm, and the a. vermicularis or thread-worm, both of which species inhabit the intestine, may escape through a recto-vesical fistula. The strongylus gigas, occasionally infesting the kidney, passes down the ureters. The spiroptera hominis were discharged from the bladder of a patient, for a period of thirty years, whose case is mentioned by Sir W. Lawrence; and many of the dactylius aculeatus, a small round worm, were voided from the bladder of a female child, in a case authenticated by Mr. Curling. Hydatids also have been known to travel out by the urethral passage, in rare cases, recorded by Dr. Sieveking and Mr. Simon. Dermoid cysts sometimes ulcerate into the bladder, and discharge their contents—teeth, hair, or other constituents. But the surgeon may be glad to turn from things which are rare and curious, to resume the course of experience that concerns him, far more commonly, in the practice of his art.

CHAPTER III.

URINARY CALCULUS—LITHOTOMY AND LITHOTRITY.

I NOW approach a subject around which, as a central figure in Surgery, has gathered a vast array of detail, and the difficulty lies, not in the exclusion of much which might be introduced, but in the selection of that which will best exhibit a faithful view of the whole; just as an artist desires to catch the lineaments of his attractive model, that he may at least present a portraiture true to life. The descriptive representation of the subject on which we are entering, may be taken from my general work on 'Surgery;' but the picture, as it were, will be finished more completely, by throwing in much practical detail, more suitable to the character of this special treatise.

Urinary calculus signifies a concretion of one or more of the constitutents of the urine, forming a hard mass or stone. The *production* of such calculus will be noticed in connection with the pathology of urinary diseases; but the seat of origin may be either in the kidney or the bladder, giving rise to calculus,—*renal* or *vesical*. Usually, it originates in the kidney, and subsequently descends through the ureter, as a small stone, into the bladder, where it increases by further concretion.

Renal Calculus.—A stone forming in the pelvis of the kidney may, or may not, be attended with pain or other symptoms of nephritic irritation. Frequently, it remains quiescent and unsuspected when lodged in this dilated portion of the ureter (Fig. 16). It may there attain a large size and remarkably irregular shape, being moulded to the pelvis and calices of the ureter within the hilus of the kidney. Absorption of the kidney-substance results from the continued pressure, and this is attended with pain in the lumbar region and symptoms of nephritis. In rare cases, abscess has been known to ensue, and the stone discharged through an aperture in the loin.

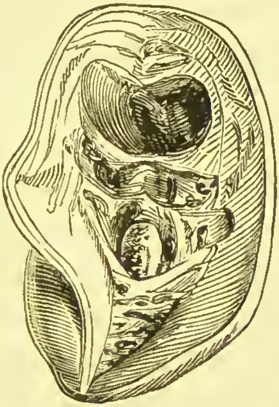


Fig. 16.—St. Mary's Hosp. Mus., H. *a*. 23. Calculus in the pelvis of kidney; the stone has the form and size of an acorn, and its surface is beset with hard, spinous projections. Probably oxalate of lime. Patient died of tubercular meningitis, with cavities in both lungs. (Dr. Alderson.)

A *small* stone in the pelvis of the kidney usually descends through the ureter into the bladder; it gradually increases in size, as a vesical calculus, by accumulating concretion on its surface.

The *descent* or passage of a renal calculus is accompanied with more or less severe pain and constitutional disturbance, in proportion to the size and shape of the stone. A small, smooth stone may descend without occasioning any notable suffering. A larger-sized and rough stone, as a mulberry calculus, descends with much difficulty, and causes proportionate agony. After, perhaps, some symptoms of nephritic irritation, the patient is seized with sudden and excruciating pain in the loin, extending down the course of the spermatic cord to the testicle, which is often retracted, and down the thighs. This agony may double-up the patient, and make him roll on the ground, vainly seeking and imploring relief. It is worse to bear, and to witness, than the pain in passing a gall-stone. Bloody urine, vesical irritability and frequent micturition, with vomiting and constitutional irritation, are the additional symptoms of a descending renal calculus, and which simulate acute nephritis. But the constitutional disturbance is not febrile, the pulse remaining comparatively unaffected, or getting small and feeble, as prostration and the other symptoms of collapse ensue. These symptoms continue, with several remissions, from generally twelve to twenty-four hours—the usual period occupied by the descent of a renal calculus; when, on its entering the bladder, all the symptoms suddenly cease. This origin, course and character, and termination of the symptoms determine the diagnosis. Sometimes the calculus becomes impacted in the ureter, and symptoms of calculous pyelitis supervene; or, if the other kidney be diseased, suppression of urine and uræmia may be induced. Stricture of the ureter may result from the passage of a rough calculus; or when, occasionally, it remains impacted in the ureter, this tube is gradually much dilated above, while the kidney undergoes atrophy and degeneration. When the stone has become vesical, and is lodged in the bladder, the symptoms of stone in the bladder begin.

Treatment.—Only palliative measures are available. Opium is the most efficacious anodyne for assuaging the nephralgic pain, and the patient can be kept under its influence during the whole period of passing the stone. Chloroform may, however, be administered with advantage, from time to time, as a relaxant. The warm bath is also a most serviceable adjunct. Cupping in the loins, followed by warm fomentations, may afford some relief. The bowels should be thoroughly emptied by mild oleaginous enemata, and diluent drinks freely allowed.

STONE IN THE BLADDER.—A stone, *loose* in the cavity of the bladder, falls into the most dependent part, behind the prostate; but it shifts about according to the varying posture of the patient. The *symptoms* produced, arise from the mechanical irritation and the obstruction caused by the stone as a foreign body in the bladder. Sometimes scarcely any inconvenience is experienced for months, or even years; generally, however, symptoms are gradually developed, and there is great suffering by the end of two years.

The early symptoms of stone-formation in the bladder are very insidious. And here I take the liberty of transcribing the description of these symptoms, and their development, as given, and quite accurately, by Sir H. Thompson; for I think *that* history of the slight and intermittent inconvenience, rather than suffering, occasioned by the formation of a vesical calculus, will clearly show how highly improbable it is that a patient with a small stone in the bladder should thus be led to seek relief—and, therefore, at a time, and under circumstances relating to the urinary organs, as well as the size of the stone, when lithotrity might indeed be recommended as the only warrantable operation, instead of lithotomy.

Taking, for example, the ordinary case of uric acid, or oxalate of lime, formation, the question is put—" What is the ordinary or typical history of a stone case? You will find a healthy-looking man, with good family history as to longevity, but often tainted with gout, one or two cases of it existing antecedently or in a collateral branch; or, in its absence, some record of gravel or stone in an ancestor. At middle life he finds uric acid in his urine, as a brick-dust deposit, more or less persisting. Soon after a small bit of gravel passes, with or without a marked attack of renal pain; if the latter, he is at the time much relieved perhaps by medicine; but often no special treatment or regimen is adopted at this critical point in his life to check the tendency now fully developed; so, after an interval, another and another little stone passes, and then no more for a few months; and although some suspicious symptoms appear, they are thought very lightly of, especially as the man has not during the last nine or twelve months passed any gravel as he used to do. Whereupon he congratulates himself, and is congratulated—not prudently; and the suspicious symptoms are so often attributed 'to that little weakness of the bladder which all people have as they get onwards in years.' Delusive axiom! But what are these suspicious symptoms? Not very marked, but ample to render almost certain to the experienced observer that that interval of freedom from passing gravel only marks an advancing stage of the malady, and shows that the gravel is now too large to pass the urethra; that in the bladder is a small stone growing by accretion, and consuming surplus uric acid for that purpose day by day. The frequency of micturition is greater by day, during movement, than by night, during rest—a condition altogether contrary to that of the 'weakness in advanced years' (prostatic hypertrophy), when the frequency is almost always greater by night than by day. A slight pain—a mere passing sting—is mostly present, at the close of the act of micturition, in the end of the penis; while, on the contrary, in the 'weakness' aforesaid, the pain, if any, occurs from a distended bladder, before micturition, and is relieved by the act. Next, some day, after an unusual walk, or it may be after an hour or two in the saddle, a little blood was observed in the urine first passed afterwards; soon forgotten, or if named to the attendant, was followed by the recommendation not to take such exercise again; but this significant sign unhappily aroused no suspicion of the true cause; so, such exercise not being taken again, the occurrence did not reappear, which again comforts everybody" ("Lectures"). But, under these circumstances, the existence of a small stone in the bladder may be strongly suspected.

The symptoms, when *developed*, are always essentially the same in kind, though modified in degree in different cases, and may be comprised under four heads: pain, chiefly in the glans penis; irritability of the bladder, with increased frequency of micturition; obstruction occasionally to the passage of urine; and morbid conditions of the urine, bloody urine in particular. In addition to these four indications, which severally may arise from other causes than stone, there is the physical sign of a hard body elicited by *sounding* the bladder with a metallic instrument, whereby a stone can be felt and heard when struck—the sensation and sound as of a stone being transmitted through a metallic instrument to the hand and ear. This touchstone, as to the presence of a calculus, is conclusive, when available; and it alone is far more diagnostic of stone than all the mere functional symptoms of its presence.

Taking these symptoms in the order mentioned, their respective *characters* must be noticed more particularly. The *pain* is that of a dull weight about the neck of the bladder, and perhaps an uneasy sensation extending to the lower part of the abdomen, the perineum, or thighs, or even to more remote parts, as the knee, heel, foot, or arm; but the pain shoots along the urethral or undersurface of the penis, and centres in the *glans*. Here the pain is more acute, and it is aggravated *after* each act of micturition, when the stone settles down on the more sensitive trigone vesicale of the bladder behind the prostate. In consequence of this pain in the glans penis, children acquire the habit of constantly handling and pulling the prepuce, whereby it becomes enlarged and elongated; the recumbent position also is often sought instinctively in passing water, to relieve the recurring attack of suffering. The *vesical irritability* and frequent desire to evacuate the bladder, are in like manner aggravated *after* micturition; for as the urine is strained off by an urgent effort, the stone settles down on its sensitive bed, and is grasped by the contracted bladder. Micturition, therefore, is not unfrequently spasmodic and involuntary. I have known a most urgent micturition to occur every ten minutes or quarter of an hour, especially during or after exercise, The semen may be ejected at the same time, and sometimes with troublesome priapism; and there is a tendency to prolapsus of the rectum, in consequence of the oft-repeated straining and spasmodic efforts to relieve the bladder. When the bladder is empty, any movement of the body will be more or less communicated to the stone, which rolls about with every change of posture. Personal experience soon restrains the sufferer's movements. Exercise is avoided, and he shuns any sudden or violent exertion; the pain is increased also by any jolting motion, as in jumping, riding, or driving. The *urine,* passed frequently, and in small quantities at a time, may flow freely, in a full stream; but it is ever liable to *stop abruptly,* owing to the stone being washed forward suddenly against the neck of the bladder, thus closing the urethral orifice; a small, smooth stone, as more often the uric acid calculus, having especially this symptomatic effect. Inflammation commences at the sensitive and vascular neck of the bladder, spreading over the mucous membrane, until general cystitis is established. The *character* of the urine changes. It becomes clouded and sometimes loaded with mucous or muco-purulent deposit, which may clear off as the bladder gets reconciled to the presence of a stone; although attacks of cystitis recur, from any unusual exercise, or an irritant state of the urine from errors of diet, or exposure to cold. This chronic cystitis leads to phosphatic deposit; coating the calculus, perhaps, and thus increasing its size—whatever may be its original composition.

In an *early* stage of stone-formation, the state of the urine may be taken as partly an indication of the *kind* of calculus in the bladder. When the urine is clear, and of a bright amber or golden colour, the stone will probably be either uric acid or oxalate of lime; while a turbid urine, with a constant deposition of lithates, in the form of reddish or pink-coloured sand, is associated with a calculus consisting of lithates or urates. As these three kinds of stone increase in size slowly, the corresponding states of urine in such cases may continue for a period of some months or longer. At length, however, the stone acquires sufficient size, and roughness of surface—in the case of oxalate of lime—to induce cystitis, from the prolonged irritation of the bladder by a foreign body; and inflammation of the vesical mucous membrane is attended with a deposition of phosphates in the form of white sand, mingled with muco-purulent matter, the urine becoming turbid, and of an orange-brown colour. In such case, the urine is ammoniacal, and the deposit consists of the ammoniaco-magnesian phosphates. Phosphatic urine having reference to an alkaline state of this secretion—not from ammonia—is also accompanied with a deposit of white sand, consisting of the phosphates of lime and magnesia, which are insoluble in alkalies; but this is unaccompanied with muco-purulent matter, the urine becoming only slightly turbid, and of a pale yellow or whey-colour. In either case, phosphatic deposit incrusts the original stone-formation; and the urine bears evidence of this change in the calculus, which now grows more rapidly, and may attain to a large size.

But in any case of stone-formation, the urine is often tinged or streaked with *blood*, sometimes amounting to vesical hæmorrhage; and this symptom may continue for a long period. *After* micturition or any rough exercise, bloody urine is more apt to occur, from attrition of the stone and interior of the bladder.

All the symptoms of stone are more or less *pronounced* according to the size and shape of the *calculus*, as a foreign body in the bladder. A large-sized stone is usually attended with more marked symptoms; and an irregular rough stone is productive of the most severe symptoms. But the duration of the symptoms affords no indication of the size to which the stone may have grown; for lithic acid and oxalate of lime calculi increase slowly, whereas phosphatic calculi more rapidly attain to perhaps a large size. The kind of calculus—with reference to its chemical nature—has some influence on the severity of the symptoms, but chiefly as depending on the constitutional diathesis. The quality of the *urine* will also affect the severity of certain symptoms; a highly acid or alkaline state of the urine having a stimulant action on the interior of the bladder, the pain and vesical irritability are aggravated. The condition of the *bladder* itself, when inflamed, whether by irritation of the calculus or its continuance, has a similar influence on these symptoms. Phosphatic calculi imply a previously disorganized state of the bladder or chronic cystitis, and thence the accompanying local and constitutional disturbance of this state.

Enlargement of the Prostate renders all the symptoms of stone less pronounced. The calculus lies usually in a receptacle behind the elevated prostate—especially when the middle lobe is enlarged; being thus removed from the sensitive vesical neck, the pain in the glans penis, and the vesical irritability, with increased frequency of micturition, are much relieved; the embedded stone is less apt to fall on the vesico-urethral orifice, and suddenly obstruct the stream of urine in micturition; and bloody urine is less liable to occur from movement in the bladder. In sounding the convexity of the instrument may glide over the stone in its receptacle, which thus escapes detection. A short sound should be used, curved or beaked, and turned down into the post-prostatic hollow. Ulceration of an enlarged prostate aggravates the pain, and the vesical irritability to the highest degree of intensity.

Age very much affects the tolerance of the bladder for stone, and thence aggravates or mitigates some of the symptoms, particularly the pain and vesical irritability, and the tendency to cystitis. In childhood, the former symptoms are often severe, but the urine remains unclouded; in manhood and middle life, or during the period of sexual activity, the pain and vesical irritability are even more distressing, and there is also far more tendency to vesical inflammation; while in old age, the more atonic state of the bladder tolerates the presence of stone without much suffering; but the chronic cystitis is much increased by enfeebled health, and frequently by retention, from prostatic enlargement, or in consequence of old-standing stricture.

Sounding the Bladder.—A *sound* is a solid steel instrument, shaped like a catheter; but with a shorter curve, and having a bulbous extremity, and a broad, flat, smooth handle. It should be smaller than a full-sized catheter, this reduction and its shorter curve enabling the instrument to be freely turned about in the bladder; while its enlarged extremity will aid in detecting the stone, and its expanded handle render the sensation communicated more perceptible to the touch. A proportionately smaller instrument, and with an abrupt curve, will be suitable for children, in whom the bladder is situated higher up in the pelvis than in adults. Sir H. Thompson's catheter-sound, or searcher, has a cylindrical and fluted handle, like a lithotrite, and combines the advantages of a catheter and sound; whereby the bladder can be partly emptied or injected, as occasion may require. Sounds of various sizes and curvature will be required for different cases.

Sounding is performed in the following manner:—Chloroform having been administered only when the bladder is unusually sensitive or irritable and spasmodic, or the patient is too restless for examination—the bladder should contain three or four ounces of urine, or having been distended to that amount by injection with warm water, and the patient lying in the semi-recumbent position; the instrument is warmed, conveniently by slipping it up the arm of the operator for a few seconds, then well oiled, and passed gently along the urethra into the bladder. Its cavity is explored, first along the inferior surface by raising the handle of the sound and passing its convexity from the neck of the bladder in a sweep backwards (Fig. 17); then the bladder should be explored laterally, by revolving the handle from side to side between the fingers and thumb; lastly, the instrument should be withdrawn to the neck of the bladder, and the point turned downwards to the depressed space behind the prostate, and then upwards to behind the pubes—the free movement of the beak in the former situation, or its reach upwards in the latter part, being facilitated by depressing the handle of the instrument between the thighs. The space behind the prostate may sometimes be advantageously tilted forwards by introducing the finger into the rectum; a proceeding chiefly requisite in old persons.

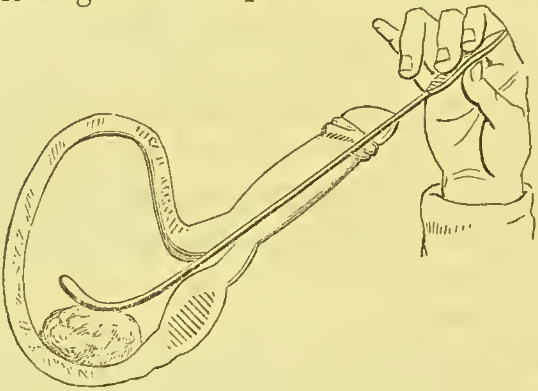


FIG. 17.

In all these manœuvres, the instrument is used with a gently tapping motion, in order to strike the stone. It should be remembered that the bladder is often very sensitive, and disposed to bleed, owing to long-continued irritation; so that anything like rough manipulation would be unsurgical. Even the patient may be acutely sensitive, and would undergo the shock of injury from any such use—or abuse—of the instrument "Ah!" was the remark I once heard, "pain is *pain* to me." Failing to discover a stone in the recumbent position, the bladder should be sounded with the patient standing up, and with a more or less than moderately distended state of the cavity. These resources having failed to present the stone, a second exploration may be made in the course of a few days.

The knowledge gained by sounding comprises more than the fact of the presence of a stone. Its *situation* is generally found to be on one side of the neck of the bladder, more frequently to the right; or when small-sized, it usually lies backwards towards the fundus or buried in the space behind the prostate. (See Fig. 17.) Its *size* is less clearly ascertainable, but this may be guessed by observing the extent of hard surface over which the sound passes, and the readiness with which the stone is found in all conditions of the bladder; while the resistance offered by the stone to move it from its position, will afford some estimate of its *weight*. By introducing a lithotrite, the dimensions of the calculus can be measured in all directions, as indicated by the separation of the blades; and in raising the stone from the base of the bladder, an experienced hand may thus also somewhat appreciate its weight. The size and weight of the calculus together represent the *quantity* of matter—a very important consideration relative to the amount of *debris* which would have to be evacuated from the bladder were lithotrity performed. The *shape* of the *surface*, whether rough or smooth, is tolerably perceptible to the touch; and the *density* or hardness of the stone can be estimated almost precisely by the sound elicited on percussion with the instrument—by, in fact, *sounding*. A hard calculus, as the oxalate of lime or uric acid calculus, rings when struck, so as to communicate a click audible to a bystander at perhaps a distance of some yards off; a soft calculus, consisting of phosphates, conveys a dull earthy sound, perhaps scarcely audible to the operator. The grating rough sensation and slight sound of a fasciculated bladder, perhaps overlaid with phosphatic deposit (Fig. 18), must not be mistaken for a distinct calculus.

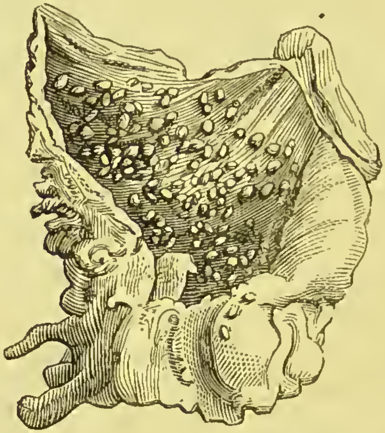


FIG. 18.—Roy. Coll. Surg. Mus., 2,024. Bladder, showing the mucous coat beset with numerous white calculi, of small size, an angular, irregular shape, and *adherent* in little depressions on the surface of the membrane. At the lower and back part of the bladder these calculi are most closely aggregated, and, with intermediate deposit, form an incrustation. The prostatic urethra is also the seat of several such *adherent* calculi. Others lay loose within the cavity of the bladder. From an old man who had symptoms of stone for a long time before death. (R. Liston.)

A second calculus, or the presence of several calculi, can sometimes be distinctly detected by the sound, a stone perhaps lying on each side of the bladder; the introduction of a lithotrite will, however, surely determine the question, when one stone is seized and another struck with the instrument still holding the first in its grasp. Sir H. Thompson has devised and employed a modification of the lithotrite, which acts as a sound, catheter, and measurer. It goes by the name of Weiss's catheter-scoop with stop-cock.

On the other hand, sounding may *fail* to discover the presence of stone, and such instances have occurred in the hands of the most experienced Surgeons; as Cheselden, Pelletan, and Dupuytren. In some cases, *large* calculi, of the size even of a hen's or duck's egg, nearly filling the bladder, have escaped the most careful and minute examination; instances of which are related by Verzascha, Benevoli, Duretus, Riverius, Marcellus Donatus, Chesneau, Valentin, Riolanus, Morgagni, Covillard, Tolet, Morand, Deschamps, and Chopart, and by Gross as having occurred in the practice of Sir B. Brodie. *Several* calculi cannot always be detected; Collot extracted from the bladder twenty-two previously undiscovered calculi, which were hard and the size of a hazel-nut. Failure has occurred also after *repeated* exploration, as in the hands of Abernethy, who thus failed to discover a large, rough, oval calculus. In some such cases, the stone has remained undiscovered for years, until *after death.* An instance of this kind I remember to have heard from the late Mr. Thomas Morton (Surgeon to University College Hospital) as having happened in his own practice; an instrument had been constantly passed also by many eminent Surgeons during a period of fifteen years, and yet no stone was found until after death. In other cases, and not unfrequently, a stone may be distinctly felt at one time, and not at another; a remarkable instance of which fell to my own lot. I had distinctly touched a small stone, lodged apparently in the *cul-de-sac* behind the prostate, and it was also felt by other Surgeons; yet, a few days afterwards, when about to operate, I could not detect the stone as the patient lay on the table, nor could it be discovered by Mr. Coulson, sen., or by Mr. Gutteridge; the latter skilled lithotomist having explored the bladder in various states of distension, and the patient standing up. About a month afterwards, the patient came to me with the stone in his hand; he told me that he had been seized with an intolerable desire to pass water, and as if the passage would burst, when the stone suddenly shot out and rolled across the room. Lastly, a calculus may be found *apparently*, by sounding; and then the unhappy mistake has been made, of cutting for stone and finding none. This misadventure has, however, happened to the most experienced Surgeons: to Cheselden, who on three occasions cut and found no stone, Crosse also, Roux, and Dupuytren, not to mention other skilled lithotomists, each of whom have thus performed abortive operations. Velpeau was acquainted with four such instances; S. Cooper knew of seven; and Coulson can refer to at least seven cases, at two of which he was present, where patients have been subjected to lithotomy, with the absence of any stone in the bladder. Strange to say, many of the patients who were thus subjected to operative operations, as for stone, were at once cured of the symptoms referable to its existence in the bladder.

Sounding is an operation not wholly free from danger.

It may induce cystitis and peritonitis, terminating fatally. Sanson, Civiale, Crosse, and others have recorded such fatal cases. With all possible lighthandedness in sounding, severe cystitis is sometimes provoked; as happened in a case where Dr. Gross had sounded a young man, who was, however, the subject of stone of twenty years' duration, and accompanied with chronic cystitis. Nor should the shock of injury be overlooked, as occurring in some cases; although the administration of an anæsthetic will be a safeguard against this contingency.

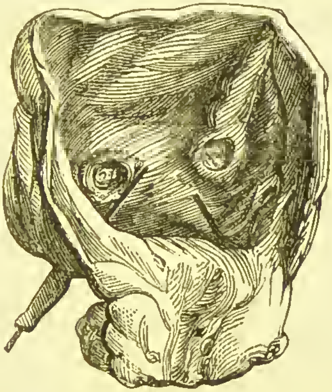


FIG. 19.—Roy. Coll. Surg. Mus., 2,019. Sacculated bladder; two extrusions of the mucous membrane contain each a calculus, exactly filling the sac, and partly covered by the membrane, without projecting into the bladder. (John Heaviside.)

Encysted calculus is so named when the stone is lodged in a cyst or pouch of the mucous membrane, between the muscular fasciculi of the bladder (Fig. 19). The symptoms of stone—as caused by a loose, hard body rolling about in the bladder, are necessarily *absent*. There may be some pain and weight, with increased frequency of micturition, arising from the irritation of a foreign body; but there cannot be any aggravation of these symptoms after each act of micturition, and much increased by any jolting exercise—the stone being stationary; nor any sudden stoppage of the stream of urine, and constant liability to the admixture of blood. Then, again, sounding gives less positive evidence as to the presence of a stone. The encysted condition may be suspected; if the stone be struck just once in a way,—when its exposed surface is hit by chance, and if it be always found at the same part of the bladder, being also immovable from its position; or if the stone can sometimes be easily felt, and at other times not felt at all,—owing to its escape occasionally into the bladder and back again into the cyst. A large encysted calculus having been struck, may perhaps be defined with the bulb of the instrument; not as an isolated stone, but through the mucous membrane, as a projecting tumour. This comparative absence of symptoms occurs also when a culculus, at first loose in the bladder, *afterwards* becomes encysted.

Apart from the question of stone in the bladder, sounding supplies valuable evidence as to the sensitiveness and irritability of the organ, its capacity, and state of the interior, with reference to the smoothness or fasciculated character of the surface, the presence of encrustation or of a tumour. The condition of the prostate gland also, and any enlargement of the middle lobe especially, can also be ascertained by means of the sound; while the state of the urethra, and of the prostatic portion more particularly, will be appreciated in passing and withdrawing the instrument.

Diagnosis.—The symptoms of stone, taken *severally,* may, when *present*, be due to other diseases of the bladder. A pedunculated growth from the middle lobe of the prostate or in the bladder is apt, during micturition, to flap over the urethral orifice and thus abruptly arrest the flow of urine. Ulceration of the prostate, or malignant disease of bladder, both give rise to hæmorrhage. Lastly, the pain and vesical irritability may be due simply to cystitis, or signify neuralgia of the vesical neck; or be sympathetic only of an impacted and inflamed testicle within the inguinal canal, in the more rare case of undescended testis. We should therefore not be misled by the presence of any one symptom, but be guided by an *association* of the symptoms in respect to urinary calculus, as in the diagnosis of nearly all other diseases. Even the positive evidence afforded by sounding will often be masked when the prostate is enlarged, or the calculus is encysted. And, as Sir B. Brodie observed, the pain and vesical irritability are often much diminished by the prostatic condition; owing probably to the enlargement protecting the more sensitive neck of the bladder from the weight and friction of the stone. Lastly, in aid of our diagnosis, the age of the patient should not be overlooked; the prostatic and vesical affections to which the symptoms may severally be due, being almost out of the question in childhood,—when, however, bladder symptoms of stone may arise from hyperacidity of the urine, intestinal irritation, or other causes of urinary incontinence, as occurring at an early period of life. In adult and advanced age, the patient's constitutional predisposition and hereditary tendency, as in relation to gout, should also be taken into account.

Difficulties, and sources of *fallacy*, in the way of sounding may be thus enumerated: a large and deformed bladder; a contracted bladder, unable to contain fluid; a sacculated or encysted bladder; an irregular hour-glass contraction of the bladder, obstructing the passage of the sound into one of the compartments; calcareous matter adherent to the walls of the bladder; calculi in the prostate and urethra; enlarged and roughened prostate; and tumours at the neck of the bladder. The calculus itself may be coated with blood or mucus.

In the *female*, the symptoms of stone are similar to those in the male. Sounding is very easily accomplished, the straight and short urethra readily admitting the instrument and exploration of the bladder. The sound should, therefore, be shorter and less curved. By introducing the fingers into the vagina, the stone can be tilted forward, thus facilitating the examination.

Consequences, and Terminations of Stone in the Bladder.—The bladder, prostate, ureters, and kidneys undergo important structural changes, chiefly of a destructive character. With these changes in the urinary apparatus, exhaustive constitutional disturbance ensues. The *bladder* becoming extremely sensitive, especially behind the prostate where the calculus commonly rests, the urine is expelled at short intervals, and a contracted state of the bladder results. Sometimes, however, it falls into an atonic and dilated condition, with retention of urine, which undergoing decomposition assumes an ammoniacal and offensive character. In either state, more particularly the latter, chronic cystitis frequently supervenes, subject occasionally to attacks of acute cystitis, with muco-purulent urine. A fasciculated condition of the interior of the bladder usually results, in consequence of a hypertrophied development of the muscular bands beneath the mucous membrane; and not unfrequently between these fasciculi a hernial protrusion of the mucous membrane occurs, forming a pouch or cyst, in which the calculus is apt to lodge, as an encysted calculus. An ulcerative and discoloured sloughy state of the mucous membrane sometimes sets in; or a parietal abscess may form, which opening into the bladder, may receive the stone into its sac, and thus the calculus becomes encysted. Ulcerative perforation of the bladder has been known to happen, allowing the stone to escape into the peritoneum, or perhaps into the rectum, vagina, or perineum. Pelvic cellulitis sometimes happens, with diffuse suppuration. Peritonitis is even a more rare event. These results have probably been induced by injudicious sounding. The *prostate* usually becomes in some degree enlarged, whereby a depression or pouch forms behind it, as a frequent receptacle for the stone; inflammation and abscess of the prostate may also occur. The *ureters* undergo less marked changes; generally they are somewhat dilated, and thickened by chronic inflammation, especially at the pelvic portion adjoining the kidney. This organ is the seat of the most serious and ultimately fatal disorganization. Thus, the *kidneys* may be affected with chronic nephritis; and sometimes with the acute form of this disease, terminating in suppuration and a speedily fatal issue by uræmia or pyæmia. Degeneration more commonly takes place as the consequence of chronic nephritis, and death results from albuminuria.

This, the ordinary course of stone in the bladder, extends over a longer or shorter period of years; varying very much according to the kind of calculus, the constitution, and age of the patient. Nevertheless, the course, although more or less slow and the symptoms more or less severe, is always progressive in its tendency to a fatal issue. As a set-off to this mode of termination, a spontaneous cure now and then takes place, by the expulsion of a small stone through the urethra in the act of straining micturition; and far more rarely, the stone has been ejected by ulceration of the bladder through the rectum, vagina, or perineum, a safe passage having been provided by adhesive inflammation or abscess. In rare cases, *fracture* of the stone occurs after rough exercise, or a fall on the abdomen: the same result being sometimes produced by the concussion of two or more stones in the bladder. The fragments are more or less completely voided in passing water; and thus all the symptoms of stone, which are temporarily aggravated, may soon subside, as if the patient had been relieved by lithotrity. Cases of this kind are mentioned by Heister, Crosse, and Brodie, as at least remarkable incidents in the clinical history of vesical calculus.

Treatment.—The *remedial,* as well as the *preventive,* treatment of vesical calculous affections, comprises those measures—medicinal and hygienic—which have reference to the calculous diathesis, in each particular kind of urinary deposit; a subject reserved for special consideration with Urinary Diseases. The various morbid conditions of the urinary organs, resulting from the presence of calculus as a foreign body—chiefly irritability of the bladder, and cystitis—have already engaged our attention.

Operations.—The treatment of Stone in the Bladder consists of the various *operative* procedures appropriate for the removal of stone. Three methods have been devised, two of which are established operations: (1) lithotomy, or the extraction of stone by a cutting operation; (2) the removal of stone mechanically by instruments, without a cutting operation—as by lithotrity, or crushing in the bladder and extraction piecemeal through the urethra, or sometimes by simple dilatation of the urethra; (3) solution of stone by chemical agents or lithontriptics, or by the agency of electricity—electrolysis. Having regard to the desirability of these several methods of procedure, it might seem proper to notice the latter, or removal by solution, first; but in consideration of the far superior efficacy of the other two methods, they will be described almost exclusively; and first lithotomy, as being the operation perhaps more generally applicable in the hands of most Surgeons.

LITHOTOMY, or the operation of cutting for stone in the bladder, has been performed in various ways; both as with regard to the seat of operation and the method of its performance. There are three situations in which the bladder may be entered: in the perineum, the supra-pubic or hypogastric region, and through the rectum; thus indicating three principal operations of lithotomy—perineal lithotomy, the supra-pubic or high operation, and the recto-vesical operation. Perineal lithotomy comprises *four* varieties: (1) the ordinary *lateral* operation of Cheselden, and as modified in detail by Key, Liston, and other modern lithotomists; (2) the *median* or Marian operation, revived by Vacca, and as modified by Civiale, Buchanan, and established in modern surgery by Allarton; (3) the *bilateral* or transverse operation of Dupuytren; (4) the *quadrilateral* section of the prostate by Vidal de Cassis.

Preparation of the Patient for Lithotomy.—Some Surgeons, as Key and Coulson senior, have paid great attention to the state of the patient's constitutional health preparatory to operation; other Surgeons of equal eminence, as Liston, have not deemed it necessary to delay the operation by much preparation. The nervous system being tranquil, or subdued by an occasional opiate, the skin acting freely, and the urinary secretion having been corrected, as far as possible, by alkalies or acids, according to the character of the calculus; the bowels should be well relieved by mild purgatives, and the rectum especially must be emptied by an enema of castor oil and soap-suds on the morning of the operation. On no account should the operation be performed until the enema has come away, the loaded state of the bowel much increasing the liability of wounding this part.

Certain arrangements, which although simple, are indispensable to the safe performance of lithotomy. A firm, even, operating-table—such as the kitchen-table, in private practice—lightly covered with a doubled blanket so as not to present any thickness into which the buttocks might sink unevenly; a piece of waterproof covering being placed over the blanket, of sufficient length to hang down over the end of the table. Pillows are requisite to support the back. A firm stool is the most convenient seat, and it must be of such height relative to the table, that the patient's buttocks shall be level with the operator's breast when he sits down. This adjustment is easily made by experience. A small low table or a large chair should be provided, on which the instruments are laid out; and placed to the right of the operator, so that he can readily help himself during the operation, independently of any assistant for this purpose. The appliances and instruments requisite are:—a pair of bandages of coarse flannel, each about three yards long and two inches in width; two lithotomy knives or scalpels, namely, a sharp-pointed, straight-backed knife, and a blunt button-pointed knife, somewhat curved backwards towards the end; a staff, boldly curved and deeply grooved on its left side, with a good pit at the end of the groove, the size of the instrument being sufficient to fill the urethra, and the handle roughened; lithotomy forceps, straight and curved; scoops of different sizes; a bladder-searcher; and an injecting syringe, capable of holding about a pint, the nozzle fitting to a catheter. To those might be added, a gum-elastic urine-draining tube with rings at its outer end, whereby it can be fixed in the bladder with perineal tapes, after the operation. This instrument was invariably used by Liston, for apparently important reasons to which I shall presently refer; it has also been employed by other excellent lithotomists, and as a Listonian pupil, I naturally followed for a time the example of the great master. But the tube was, I believe, seldom used by Coulson, nor by other men of large experience, and it has now fallen into general disuse.

Lateral Operation.—Four assistants at least are required for the performance of this operation; one to administer chloroform, one on each side of the patient to fix the perineum in the proper position as presently described, and a fourth to take charge of the staff. A fifth assistant might be convenient to hand instruments, unless they are placed within easy reach of the operator when sitting down.

The operation consists in cutting on a staff into the bladder,—by a preliminary superficial, perineal incision to reach the instrument, followed by a deep or prostatic incision in the groove of the staff to enter the bladder; and the extraction of the stone. Thence the instruments essentially requisite are simply three; a staff, a knife, and forceps.

The patient is placed recumbent on the table, and chloroform administered. Then the bladder having been previously emptied of urine, should be injected with tepid water to the amount of about four to six ounces, supposing the patient to be an adult, in order to steady the bladder and expose the stone to the grasp of the forceps. But over-distension of the bladder will render the operation more difficult, by causing the organ to recede; and the prostatic urethra thus being elongated, the perineum becomes deepened. Sounding should now be performed, immediately before the operation is commenced,—when the patient's bladder is in position. This may be done with an ordinary sound; but it is preferable to at once introduce the staff of sufficient size to occupy the urethra—and, using it as a sound, the stone must be distinctly felt and its situation ascertained. This is an imperative rule in regard to lithotomy. If the stone cannot be felt at the time of operating, the operation should be unhesitatingly postponed; if it can be felt, the operation is proceeded with. The patient is brought to the end of the table, so that his buttocks resting on the edge shall project a little beyond it; the legs are to be drawn up and the hands and ankles firmly bound together with the lithotomy bands, as thus,—either hand being placed on the outer side of the ankle and made to grasp the foot, both are securely joined in this position by a figue-of-8 application of the band. I prefer this security to the couplet leathern straps which are sometimes used. Then, the side-assistants, taking each a foot in his hand on the inner aspect of the foot, and placing the patient's knee in his axilla, the limbs are drawn sufficiently apart to fully expose and throw out the perineum; at the same time observing that it inclines to neither one side nor the other, but is fixed perpendicularly, or horizontally to the table, and maintained in this position throughout the operation. Unless these two assistants attend only to this, their simply mechanical but important duty, that of exposing and balancing the perineum, instead of attempting to hang over and see the operation, they will assuredly disturb the visual line of the operator and thus embarrass him in his incisions and manipulations.

The staff is now given in charge of an assistant, standing on the patient's left, with the injunction to hold it firmly—the thumb supporting the flat surface of the handle—in the perpendicular direction, or inclining slightly *downwards*, and the curve of the instrument being hooked up under the symphysis pubis (Fig. 20). Some Surgeons prefer that the convexity of the staff should be made to bulge slightly forward in the perineum; others that it should be turned somewhat towards the left of the perineum; while some prefer that it should be depressed, and held in contact with the stone. The assistant holds the staff between the thumb and the fingers of his right hand; the left hand is used to raise the scrotum from the raphé running down to the rectum. Thus then, the space between the urethra and the rectum is exposed as much as possible, so that the one can be more readily approached without the risk of wounding the other.

The Surgeon seating himself on the stool in front of the exposed perineum; he shaves the integument on the left side, and introduces his finger into the rectum to know for certain that the bowel is empty and to induce its contraction; whereby any remaining feculent matter will be expelled, and the contracted state of the bowel diminishes the risk of its being wounded during the deeper incision. At the same time, the curve of the staff should be felt to pass straight through the prostatic urethra, and thus enters the bladder. Then, with his left hand thumbing the tuberosity of the ischium and the ramus on the left side, he feels also, with the point of the forefinger, the sort of depression *below* the bulb of the urethra, in the middle line or raphé, which lies over the curve of the staff; a point about one inch and a half in front of the anus, rather lower than higher, and corresponding to a part of the instrument which in a thin perineum can often be plainly felt. The landmarks of his incision having thus been clearly defined; the Surgeon rests his left hand on the right half of the perineum, so as to make the skin on the left side slightly tense, and indicating with the forefinger the above spot, he plants the lithotomy-knife perpendicularly, to the left of the raphé by about one-third of an inch, and carrying the blade in a straight line obliquely downwards and outwards, midway between the anus and tuberosity of the ischium, or somewhat nearer to the latter, terminates the incision at a point just below the anus. A *free* but superficial *perineal* incision is thus made. The length of this incision will be from three inches to three and a half, in the adult; its extent varying somewhat accord-

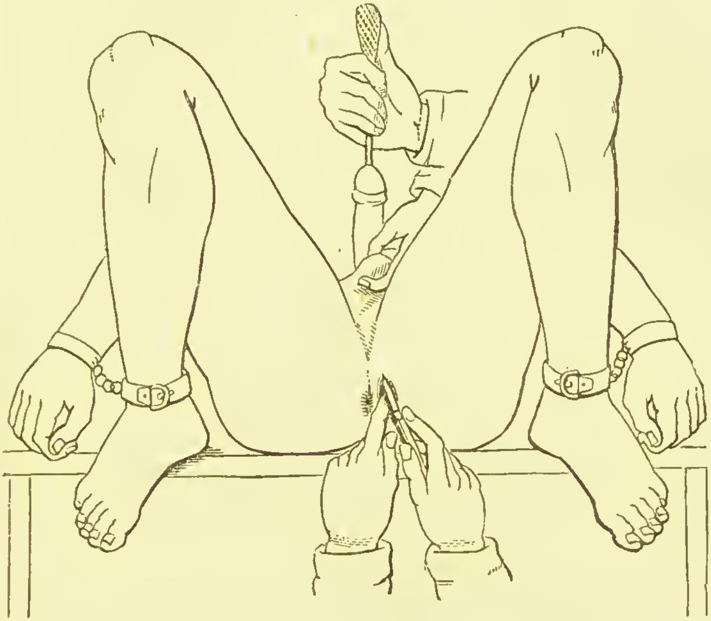


FIG. 20.

ing to the size of the perineum, and the apparent size of the stone. The skin, superficial fascia and fat are divided; but the depth of the incision, varying according to the perineal obesity, is above rather less than an inch, while below, the knife is drawn out slopingly from the ischio-rectal fossa. The upper half of this incision—above the anus, leads to the staff; the lower half—by the side of the anus and below it, facilitates the extraction of the stone. The point of the forefinger of the left hand is now drawn firmly from the upper angle, along the bottom of the wound, between the left erector penis and accelerator urinæ muscle overlaying the bulb of the urethra, so as to separate these parts; then, using the finger to protect the rectum, by pressing it somewhat downwards and to the right, any further resisting structures are divided by a slight touch or two with the knife. Thus are divided, the transversalis perinæi muscle and artery, and the base of the deep perineal fascia or triangular ligament of the urethra, which latter sometimes in elderly persons presents a tolerably firm bar to the finger. The finger is then directed *upwards* from the rectum, as a guide to the staff; the groove of the staff is felt just in front of the prostate, in the membranous portion of the urethra, and as covered therefore with this membranous structure stretching across the groove. By a little compression at this spot, the nail of the finger is lodged fairly in the groove; and then the point of the knife, with the cutting-edge downwards, is slid along the finger *over* the nail, and penetrating the membranous urethra, is at once inserted into the groove of the staff, and felt to touch the metal, the contact with which may be further assured by a slight lateral movement of the point. This relative position of the finger to the knife will securely protect the rectum —itself also pressed downwards and to the right; and which, from its proximity beneath the prostate, is especially liable to be wounded at this part of the operation—the commencement of the *deep* or *prostatic* incision. The knife is now pushed firmly along the groove of the staff, through the prostatic portion of the urethra and the prostate, with a slight inclination of the blade downwards and outwards (Fig. 21); thus incising or notching the prostate *laterally*, in the same direction as the external or superficial incision; while the point of the blade, by slightly depressing the handle to a very limited angle with the staff, follows the curve of the staff, until the bladder is entered. If the knife directed sideways, runs firmly in the groove of the staff, so as not to slip out to the left, the blade cannot go wrong and the incision must be right. The bladder is known to

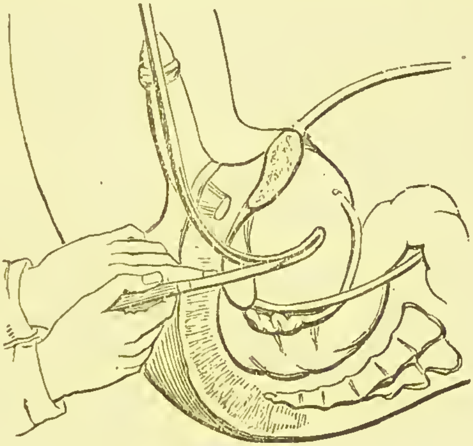


FIG. 21.

be entered by resistance ceasing, and perhaps a gush of water taking place. This incision may be made rapidly and boldly by a practised lithotomist; a less practised lithotomist must take the incision more slowly and cautiously. A *button-pointed* lithotomy-knife may perhaps be used more safely, as it locks into and has a more secure hold in the groove of the staff. Such a knife was always employed by Coulson. It is introduced into the groove of the staff, after a small puncture, to the extent of three or four lines, has been made into the membranous urethra by the sharp-pointed knife, in the perineal incision. I have never yet thought it necessary to use this instrument.

This—the deep or prostatic incision, is therefore *limited* in its *extent* through the *prostate ;* not exceeding twice the width of the blade of the knife, and certainly not passing beyond the base of the gland, where its *capsule* prevents infiltration of urine into the cellular texture of the pelvic cavity behind the prostate. In withdrawing the knife through the prostate, it should pass over the finger, in the same direction as in introducing it, and still in the groove of the staff, so as not to enlarge the incision; at the same time, the finger is pushed forward through the prostatic incision into the bladder: and, if this manœuvre be executed adroitly, the introduction of the one follows the exit of the other —the finger replacing the knife *before* the water escapes in any gush from the bladder. The finger, fitting into the incision, is made to enlarge the wound by a sort of twisting, or tunnelling motion; whereby the opening is dilated and the prostate somewhat split, as with a blunt gorget, instead of having been cut freely by the knife. As the finger proceeds—the stone is felt for. This double duty of the finger, as a dilator and a searcher, may be conveniently performed, while the Surgeon is taking the forceps with his other hand from an assistant, or from a basin of warm water at his side. Having entered the bladder, and found the stone; the assistant is directed to withdraw the staff. Then the Surgeon introducing the closed blades of the forceps over the

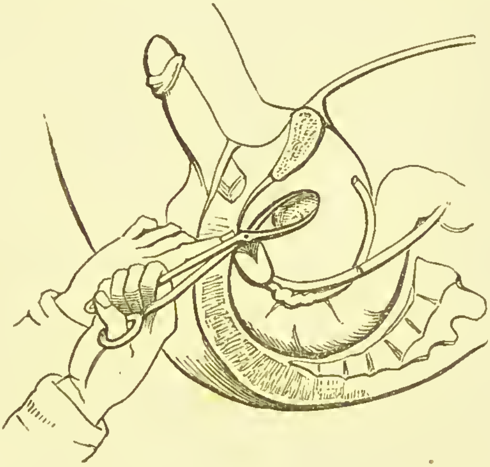


FIG. 22.

finger, he slides them into the bladder, and opens the blades, withdrawing the finger, at the same time; a gush of water now takes place—if not previously, in making the prostatic incision—and thus the stone may sometimes be washed into the grasp of the forceps; or, on somewhat dipping the forceps, with a sort of sweep from left to right across the fundus of the bladder, the stone is at once caught and seized, whereby the instrument feels suddenly locked (Fig. 22). Failing to catch the stone, in either of these ordinary ways, it should be gently sought for, and touched, with the forceps. It may then be seized by one of two manœuvres, as in lithotrity; by depressing the inferior fundus of the bladder with one blade, and giving a slight shake, the stone will probably fall into the grasp of the instrument; or by passing the blades along the side of the stone, then opening them, and turning the opened blades over to that body, it will be seized almost with certainty. The size of the stone may be estimated by observing how far the handles are separated. If it seem to be seized in its long diameter and too large for extraction, the stone may be shifted by a jerk of the forceps, or disengaged and reseized, so as to be extracted without lacerating or bruising the neck of the bladder.

For seizing and extracting the stone, various shaped forceps may have to be used; those constructed by Messrs. Matthews for Sir W. Fergusson, are here represented (Fig. 23); the angular instruments being adapted for keeping the operator's hand out of the line of incision in the act of extraction.

Extraction should be performed slowly, and by working the instrument gently backwards and forwards to gradually dilate the prostatic aperture; bearing down also in the direction of the axis of the pelvis (see Fig. 20), in order that the widest part of the arch of the pubes may be available for the extraction, and the lower part of the perineal incision which facilitates this concluding part of the operation. The forceps lie in the axis of the pelvis, and are withdrawn, in the same direction as obstetric forceps. If, as a rare event, the stone slips from the forceps, when it has been withdrawn through the prostate, it cannot be reseized under the pubic arch, or without disturbing the cellular connections of the bladder and rectum; the finger should be passed into the bowel, so as to fix the stone from behind, and then with the scoop (Fig. 24) it may be drawn or tilted out of the wound. After removing the stone, if it has a faceted shape, as from attrition, there will probably be another; in any case, however, the finger should be reintroduced into the bladder to search for any other stone which may be present; or the *searcher* can be used for this purpose to reach parts of the bladder not readily accessible to the finger, as in front above the pubes. And, as *in* the act of withdrawing the knife

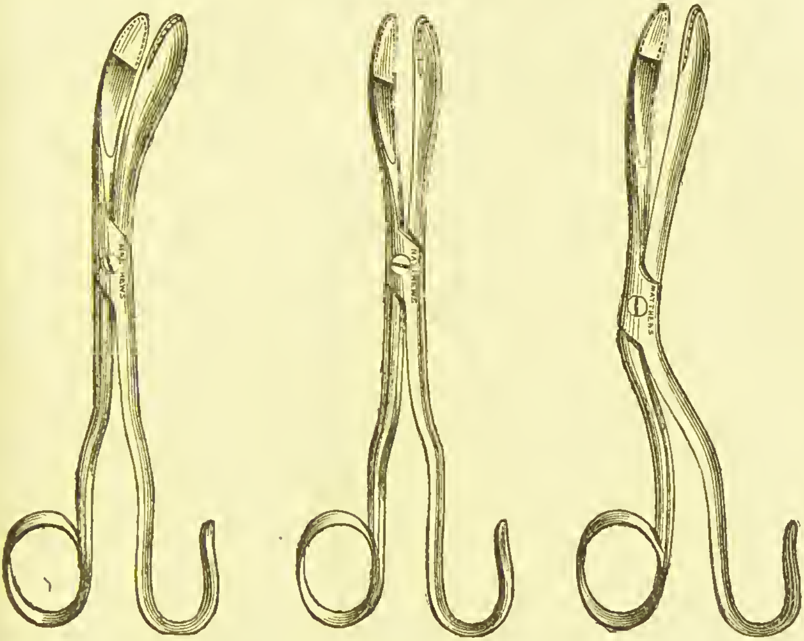


Fig. 23.

through the prostatic incision, the finger at once followed it forward, so also *in* withdrawing the forceps, the finger is again made to follow this instrument; that thus the entrance to the bladder shall never be lost—an injunction the more imperative when the staff, as a guide, has been withdrawn. No second stone having been discovered, the operation is completed.

Fracture of the stone sometimes occurs, in seizing or in extracting it; and generally as the result of undue force in using the forceps, aided perhaps by the brittle character of the stone, as when the calculus is phosphatic. This accident will be noticed among the *difficulties* which may attend the operation.

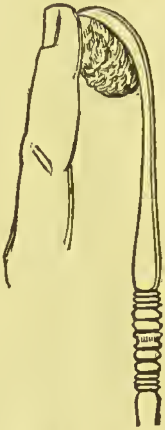


FIG. 24.

Lastly, a gum-elastic tube may then be introduced through the wound into the bladder, and retained in position by perineal tapes. This instrument was formerly deemed serviceable for two purposes; as a means of arresting any oozing hæmorrhage; and for keeping the wound free of coagula, thus affording a clear passage and preventing the infiltration of urine. But the latter risk is surely avoided by the limited prostatic incision; and the former advantage is more than counterbalanced, in *most* cases, by the incessant concentration of the patient's attention to his bladder. Originally, I believe, recommended by Collot; Liston, I know, always used this tube, so did Sir W. Fergusson, in his earlier operations, and Mr. Spence still patronizes it; but the instrument was condemned by Velpeau, and restricted in Mr. Coulson's practice to cases attended with a disposition to hæmorrhage, or employed by Sir B. Brodie only when there was a liability to infiltration of urine, either from clot-formation in the wound, or from laceration beyond the prostate in the extraction of a large stone; and the employment of the tube is now generally abandoned in this country.

I have thus described the lateral operation of lithotomy as consisting of three steps; two of which are incisions—a superficial or perineal, including a deeper touch or two with the knife, and the deep or prostatic incision; and then, seizure and extraction of the stone from the bladder. It should, however, be observed by the Student, that although these steps are described separately, as in detail, they are performed successively as one continuous operation. The procedure consists in an *alternate* application of the left forefinger and the knife, or the forceps. Commencing with the indication of the point for entering the knife in the perineum, this is followed by the superficial perineal incision; then, the finger is used successively, as a protector, guide, blunt-gorget, and searcher; with the knife alternately, in the perineal wound, the groove of the staff in the membranous urethra, and the prostate; followed by the forceps, also used alternately with the finger, in the bladder. The textures are successively divided downwards and outwards, away from the rectum, by *lateralized* incisions; and they together form an oblique *conoidal* wound, having its base externally in the perineum, and the apex in the prostate.

If the operation be thus conducted, the question of the "parts" concerned, is more an anatomical investigation than a surgical consideration—more a Student's question, than of practical consequence. The parts necessarily *divided*, in their order from without inwards, are: the skin, superficial fascia and fat, with the inferior hæmorrhoidal vessels and nerves passing across the ischio-rectal fossa; the transverse perineal muscle and artery, with probably the superficial perineal artery and nerves; the base of the triangular ligament and the deep transverse urethral muscle; the membranous urethra and constrictor muscle; the prostatic urethra, and the prostate to a limited extent in its left lateral lobe, including the "ligamentous ring or band" around the neck of the bladder, but not the capsular boundary formed by the reflexion of the recto-vesical portion of the pelvic fascia; external to the capsule, some of the anterior fibres of the levator ani muscle will be divided, and within the capsule, a plexus of rather large-sized veins must be severed—in the prostatic incision.

The parts to be *avoided* in the operation, are in anatomical works thus enumerated: the rectum, the internal pudic artery, where it courses forwards under cover of the ramus of the pubes; the bulb of the urethra; and the artery of the bulb, which normally passes inwards transversely about half an inch above the base of the triangular ligament, between it and the other or deep layer of the perineal fascia. Of these parts, the *rectum* will be avoided, by having the staff well hooked up, protecting the bowel with the finger and lateralizing the knife parallel with the bowel—particularly in an old person whose rectum is commonly dilated into a pouch just above the anus, sometimes even wrapping around the prostate from side to side. The precaution of emptying the bowel should also be observed. The arterial vessels mentioned are less readily wounded; but, when presenting anomalies, they may be unavoidable. The *pudic* artery will be avoided by not turning the knife too much outwards in making the deep incision. Posteriorly this artery is securely lodged under cover of the tuber ischii; but, occasionally, it descends over the inferior surface of the bladder, and across the prostate to reach the penis. Or, the accessory pudic, as an occasional substitute for the pudic, when defective, lies on the posterior edge of the prostate; it may then be avoided by not extending the prostatic incision backwards to the base of the gland. The *artery* of the *bulb*, a serious source of hæmorrhage, may perhaps be avoided by not cutting too freely upwards towards the groove of the staff; but an irregular course of the vessel, lower down than usual, cannot be foreseen or avoided by any plan of incision. Sometimes also, as arising from the obturator artery, or as a branch from the artery of the bulb on the opposite side, neither of these anomalies can possibly be anticipated. Lastly, the *bulb* of the urethra, a source of venous hæmorrhage, may be avoided by directing the point of the knife obliquely upwards beneath its projection, in the act of penetrating the membranous urethra. The bulb is most liable to be wounded by opening the membranous urethra anteriorly, instead of more deeply, just in front of the prostate. I agree, however, with Mr. Skey, in not attaching much importance to a wound of the bulb; and I have no doubt it not unfrequently happens without any evil consequence. The venous plexuses, within the capsule of the prostate, are sometimes much enlarged, especially in old men, and become a source of unavoidable hæmorrhage.

In the *limited* extent of the *prostatic incision*, the operation, as described, differs essentially from that of the earlier and some living lithotomists: Frère Jacques, Cheselden, Desault, Klein, John Bell, Martineau, Come, Souberbielle, Langenbeck, Gutteridge, and other most successful operators, who made a free prostatic incision, extending even through the neck of the bladder; but the limited incision has been advocated by Pierre Franco, Le Cat, Scarpa, Dupuytren, Callisen, Sir A. Cooper, Sir B. Brodie, Crosse of Norwich, Key, Stanley, Liston, Skey, Coulson, Syme, Spence, Sir W. Fergusson, and by the most experienced modern lithotomists in this country, supported by Dr. Gross, and other distinguished American surgeons.

For years I have protested against fettering the hands of the operator with many of the impracticable considerations laid down in Anatomico-Surgical works. In lithotomy, Anatomy plans the landmarks and limits of the incisions—perineal and prostatic; but the *pathological* conditions of the prostate and of the bladder are of more surgical importance in the seizure and extraction of the stone. This will appear presently in connection with the difficulties incidental to the operation.

Position of the Hand and Knife.—Much difference of opinion has been held in surgical works of authority, and different delineations have been given, as to the manner of holding the knife in lateral lithotomy. In making the superficial or perineal incision, the knife is generally held *under* the hand; and in making the deep or prostatic incision, *this* position is still maintained by lithotomists, and as shown in works on Surgery. Liston, however, would appear to have held the knife *above* the hand, in making the latter incision, as depicted in his "Practical Surgery." It is described as being a representation of "the position of the hand and knife," at the commencement of the second incision, as shown "in a very correct sketch of the viscera of the pelvis, with their relative size and position; and which has been copied more than once without acknowledgment." (Fourth Edition, 1846, p. 509.) But, notwithstanding this record by Mr. Liston, on the point in question, as an old Hospital pupil, having enjoyed unusual and repeated opportunities of witnessing the operations of the great lithotomist, I can corroborate the personal knowledge of Mr. Cadge, of Norwich, that Mr. Liston held the knife *under* the hand, like other lithotomists; and I particularly well remember also that, in entering the point of the knife into the groove of the staff, his fingers were enclosed around the blade, apparently to cover the edge, and fit the point into the groove securely, the instrument being then sent forward from the palm of the hand. But although there can be no doubt that in the Listonian operation of lithotomy, the hand and knife had the usual relative position, and *not* as represented in the work referred to; yet I am now equally certain from my own experience of the operation both on the living and dead subject, that the method actually depicted in that Fig. will be found generally more advantageous; the point of the knife being thus directed *upwards*, whereby it is kept more securely in the groove of the staff. The slight inclination of the staff downwards from the perpendicular also facilitates the passage of the knife in the groove; as in "cutting on a straight staff," without entailing the special risk incident to the manipulations in that mode of operation.

Various other *knives* have been contrived for making the prostatic incision. Besides modifications of shape, in the blade of the ordinary lithotomy scalpel, the lithotome and the cutting gorget are special instruments which were formerly much used, and perhaps have not altogether yet fallen into disuse in the hospitals of London. The lithotome is simply a knife, having a sheathed or concealed blade, which is projected by a spring, while the sheath is beaked to run in the groove of the staff. This instrument is thus perhaps safer than an unguarded and pointed knife in the hands of a clumsy operator. The gorget is a sort of concave triangular knife, of large size, and also beaked. But, although certain eminent lithotomists have handled the gorget with dexterity, this frightful weapon has often been thrust deep between the bladder and rectum, cutting either organ, and even penetrating the peritoneal pouch behind, so that the bowels have slipped down and come out of the perineal wound. Some terrible stories of this kind are told by John Bell in his "Surgery;" and similar misadventures have since been witnessed by Mr. Crosse, senr., and others, who have confessed what they have seen, or has been discovered by examination after death.

Cutting on a Straight Staff.—This mode of performing the lateral operation was originated by Aston Key, at Guy's Hospital, where it is still practised, and by other Surgeons. The curved staff, as a director for the knife, is ill-adapted in its form to guide the point with safety, just where the use of the staff becomes requisite —in making the prostatic incision. This disadvantage may be overcome by cutting on a straight staff; and the advantage is also gained, that the groove, which had been directed downwards for entering the knife, can then be turned in any oblique line for division of the prostate. But the straight staff is more liable to be tilted out of the bladder than the curved one; and therefore, the end of the staff should always rest upon the stone in performing the operation with this instrument.

Having reached the staff by the perineal incision, which has to be carried deeper than to reach the curve of the ordinary staff, the point of the knife is entered into the groove; then the Surgeon, withdrawing the left forefinger from the wound, takes the staff from the assistant previously in charge, and depressing the handle brings it down parallel with the axis of the pelvis, so as to present a direct passage to the bladder. In doing either of these acts, special care must be taken lest the knife slip out of the groove. Feeling certain that it still remains in, the surgeon lateralizes both staff and knife, in contact, to the left of the perineum, corresponding to the external incision, and pushes the knife onwards along the groove into the bladder; withdrawing it in the same direction, so as to incise the prostate only to a limited extent. Here again, in this nearly parallel mode of using the staff and knife, special caution must be taken lest the point be tilted out of the groove by the front of the prostate; when, instead of entering the bladder, it would pass down into the pelvic cavity. This may be obviated by depressing the handle of the knife to a *limited* angle with the staff, so as not to incise the prostate too far back. Then, having entered the bladder and withdrawn the knife, this instrument is laid aside; the staff is now transferred to the right hand, and the left forefinger, introduced into the wound, is guided by the staff into the bladder and to the stone. The finger resting on the stone, the staff may be withdrawn; the forceps are introduced along the finger, and the operation completed.

The Lateral Operation in Children.—Lateral lithotomy is performed in the same way in Children as in Adults; but the anatomical condition of the parts under the age of puberty and especially in childhood, affects the performance of this operation. The anatomical peculiarities alluded to are chiefly four; the looseness of the perineal cellular texture in the recto-vesical space; the small size, thinness, and weakness of the membranous urethra; the rudimentary small size of the prostate; and the position of the bladder—it being situated higher up or more in the abdomen than in the pelvis. These conditions severally affect the operation in its first part—that of entering the bladder; extraction of the stone is not attended with any special difficulty.

Thus, the superficial perineal incision having been made correctly, the *loose cellular texture* easily yields and gives way under the finger, forming a distinct, smooth-walled cavity or false bladder, in the recto-vesical space; which resembles the interior of the bladder. A very little groping with the finger, in the wrong direction—*downwards*—will form this deceptive cavity; into which the finger readily enters as if into the bladder. Perhaps also the membranous urethra has been penetrated, whereby the urine dribbles away and the bladder gradually collapses; both circumstances apparently confirming the belief that the finger is really in that cavity. Indeed, the latter condition affords more room for the easy enlargement of the false bladder. In this anxious and perilous moment, two points of distinction should be remembered; this false bladder presents *no neck* through which the finger should pass to gain admission, nor can the *bare* grooved staff be felt along the back of the finger when introduced into the cavity. Besides both these negative features of distinction, *above* this cavity, near the symphysis pubis, lies the staff leading to the bladder; and which can be plainly felt on directing the finger from the scene of mischief, obliquely upwards to that spot. Hence, the practical inferences are these: in approaching the staff, to avoid making anatomy by a too free use of the finger as a guide; and to direct both it and the knife upwards to the more highly situated staff, instead of heedlessly slipping into and working in the interval between the bladder and rectum. A precaution before operating should also be observed; that of sufficiently distending the bladder with water, to lower its position in the pelvis, and to steady its neck. I have always found also that a staff with a larger or deeper curve than usual, has the advantage of lowering the neck of the bladder, in operating on children; thus rendering the prostate more accessible below the pubic arch, and so diminishing the risk of entering the cellular space between the bladder and the rectum. The same kind of misadventure may occur between the neck of the bladder and the pubes, by misuse and misdirection of the finger *upwards.* It need scarcely be added, that in either such case the little patient remains unrelieved, and dies with the stone in the bladder. Yet this calamity has happened to some of the most skilful and experienced lithotomists—past and present.

Again, in endeavouring to hit the membranous urethra and lodge the point of the knife in the groove of the staff, the urethra being of *small size,* it may be so cut about as to be nearly severed from the prostate. Or, if the point of the finger be not insinuated well into the opening, or if any undue force be used in passing it into the bladder, the *thin* membranous urethra may be torn across, and the neck of the bladder driven backwards on, or off, the staff—an accident more likely to happen when the urethra has been nearly severed.

Thus then, in opening the urethra, as in approaching it, *fiddling* with the knife must be avoided; and in both procedures, any *forcible* use of the finger will also be mischievous.

The *rudimentary size* of the prostate, and the *high position* of the bladder, will both necessitate a more upward direction of the point of the knife, in making the prostatic incision. And it should be remembered that this incision must necessarily almost always, if not invariably, extend through the whole of the small prostate, in its left lobe; yet without any evil consequence.

In entering the neck of the bladder, the feeling is that of passing through a small ring; without riding over the sort of chestnut-like projection upwards of the prostate, and which may be like a half-orange in an elderly man.

When the prostate has been detached from the membranous urethra and the neck of the bladder recedes before the point of the finger, all the presence of mind and dexterity of the Surgeon will be required at this trying moment of peril and anxiety. Much will depend on whether the staff still remain in the bladder, as a guide. If so, the forefinger should be passed most cautiously and gently along the groove, and a slight hooking-movement made at the neck, so as to draw down this part. It may then be notched, by insinuating the knife along the finger, which can thus be fairly entered. If the staff be out of the bladder, or has been withdrawn, the position of both patient and Surgeon is most critical. It may be possible to re-introduce the instrument, and then proceed as just directed. Failing to accomplish the first step, the attempt to hook down the neck of the bladder should never be resorted to—in the absence of a *guide*. The finger or any searching instrument will only pass deeper and deeper with increasing damage, and inevitable death result. Moral courage is here the better part of valour, and any further operative interference should be resolutely abandoned. The urethra may heal, restoring the continuity of the canal, when the operation can be repeated and brought to a happy issue.

The *Difficulties* which may occur in the performance of the lateral operation relate either—(1), to entering the bladder; or (2), to seizing and extracting the stone. The former occur more especially in operating on children, and have been already described; the latter kind of difficulties are met with more commonly in adults. Thus, in *children* two difficulties are very liable to happen, in endeavouring to enter the bladder; the formation of a false bladder in the recto-vesical space, and the incised or torn detachment of the neck of the bladder from the membranous urethra. In *adults*, the first of these difficulties has occurred as the result of prolonged *boring* with the finger in the cellular interval between the bladder and rectum.

(1) A *deep perineum* presents obstacles to *entering* the bladder. The depth of perineum may be due to fat, in a corpulent person; or to an enlarged prostate, in an elderly person. Both conditions not unfrequently

coexist, coupled also with an indurated state of the prostate. A forefinger of average length can perhaps scarcely reach the bladder, if at all; and the prostatic condition of enlargement and rigidity obstructs the introduction of the finger. The *blunt*-gorget, formerly in ordinary use, is here very appropriate; as affording the means of dilating the incomplete incision in the enlarged and indurated gland, and of gaining access to the bladder beyond reach of the finger.

(2) *Seizure* and *extraction* of the stone may present difficulties dependent on several conditions: depth of the perineum, particularly when due to an enlarged prostate; an encysted, or an adherent state of the stone; the position, size, and shape of the stone; fracture of the stone; bladder difficulties, in the form of enveloping folds of mucous membrane, or hour-glass contraction; rickety deformity of the pelvis, in its antero-posterior diameter, or by narrowing of the pubic arch. These various conditions interfere with the use of the forceps; either in introducing the instrument into the bladder, in seizing, or in extracting the stone.

Enlargement of the Prostate, which places the bladder beyond reach of the finger (Fig. 25), renders the introduction of the forceps difficult; and seizure of the stone more so, owing to the liability of its falling into the depression behind the prostate, and thus escaping the sweep of the forceps; but the latter difficulty may be overcome by using long curved forceps, at the same time endeavouring to raise the stone by passing the finger into the rectum, if the fundus of the bladder can be reached behind the enlarged prostate. In dilating the prostate, a myomatous or prostatic glandular tumour has been enucleated; and this condition, which Professor Gross has met with on several occasions, is said to delay the closure of the wound. In extracting the stone through an enlarged prostate, some difficulty may be experienced; and rather than bruise or lacerate the parts, it would be proper to incise the opposite side of the prostate towards the tuberosity of the right ischium, forming a bilateral section of this body, without making any additional perineal incision. Sometimes a portion of the prostate, especially an enlarged middle lobe, may be caught in the forceps, and might be torn away. This can be detected by passing the finger up to feel that the blades of the forceps are free below, before extracting; the incision of an enlarged prostate readily allowing the finger to pass.

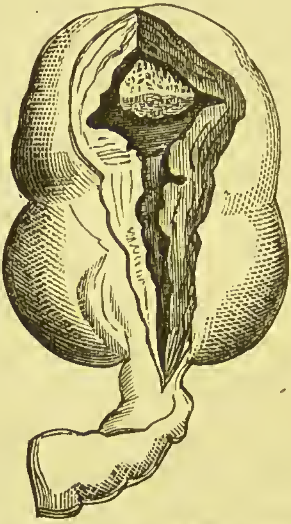
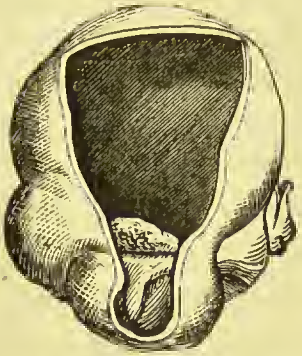


Fig. 25.—Roy. Coll. Surg. Mus., 2,036. Greatly enlarged prostate; lithotomy. Calculus remaining in the bladder, two other stones having been removed. (Sir W. Blizard.)

Encysted calculus is not very common (see Fig. 19); but if this condition be found in exploring the bladder with the finger, the course to be taken by the Surgeon should depend entirely on the size of the aperture of the sacculus. A small aperture will preclude the possibility of removing the stone, without endangering life. A large opening, or a partially encysted condition, may allow the stone to be liberated. This can sometimes be effected by a fortunate catch with the forceps; in one case, by Collot, changing the position of the patient proved successful in dislodging the stone; in another, by Sir B. Brodie, the orifice was enlarged with a probe-pointed bistoury, and the calculus turned out with the finger or scoop. The latter procedure is, obviously, extremely hazardous, since the bladder might easily be cut through into the peritoneal cavity. When, therefore, the calculus cannot be otherwise removed, and with tolerable facility, the operation should be abandoned. Sir A. Cooper removed an encysted calculus, in the case of a child, without opening the bladder in the usual manner; passing his finger into the rectum, the stone was felt and struck with a sound, then by introducing a knife through the perineum above the bowel, as in median lithotomy, the cyst was opened, and the stone extracted.

An *adherent* state of the calculus has been doubted by some lithotomists; but an indisputable case is recorded by Mr. Shaw in the "Transactions of the Pathological Society," vol. vi. The adhesion of the mucous membrane to the stone was effected by fibrous tissue, the fibres dipping into the calcareous substance; and this union was so firm that it resisted separation by tearing with the forceps. In extracting phosphatic calculi, the deposit of rough calcareous matter on the rugæ of the bladder must not be mistaken for a distinct calculus; any attempt to remove the former would of course prove disastrous by tearing away the mucous membrane with the deposit.

Position of the Stone.—Two parts of the bladder, in either of which the calculus may be situated, offer considerable difficulty to *seizure* of the stone. When lodged in a depression behind an enlarged prostate (Fig. 26), the stone must be brought up by tilting the bladder with the finger introduced into the rectum, and then using a long curved pair of forceps or a curved scoop. When situated above the pubes anteriorly, towards the upper fundus of the bladder (Fig. 27), the stone must be lowered by compressing the abdomen, as



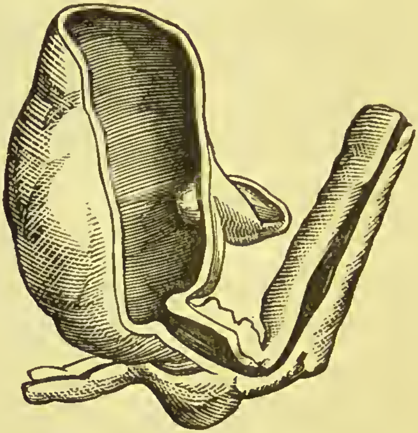


FIG. 26.—Roy. Coll. Surg. Mus., 2,028. A deep pouch at the base of the bladder, just behind the prostate; and, in this post-prostatic depression, a rough calculus, more than an inch in diameter, is lying almost concealed. (Liston.)

FIG. 27.—Ibid. 1,983. (Liston.)

Aston Key recommended, and then seized with a curved forceps or the curved scoop. In one such case, Sir B. Brodie found the stone both encysted and adherent. Raising the pelvis will sometimes enable the forceps to grasp the stone, a resource which proved successful in a case on which Mr Coulson operated.

Shape and Size of the Stone.—The shape of the stone may offer some difficulty to its *seizure* with the forceps. A round irregular stone, as a mulberry calculus, is grasped less readily than a flattened, smooth stone, which lies easily within the blades of the forceps. Irregular shaped, phosphatic calculi, present the greatest difficulty.

Both the shape and large size of the stone may offer considerable obstacles to its *extraction.* Three resources are practicable:—(1) section of the right lobe of the prostate, forming the bilateral section of this body; (2) crushing, splitting, or drilling and breaking up the stone in the bladder—by means of strong lithotomy forceps, cutting forceps or lithotrites,—thus performing perineal lithotrity; (3) the recto-vesical, or the suprapubic operation of lithotomy. Of these procedures, section of the prostate is, I am sure, the most practicable and the safest. It was recommended by Martineau, Liston, Stanley, and Coulson, rather than use undue force in attempting to gradually dilate the ordinary prostatic incision, which would cause bruising or laceration. The forceps still grasping the stone is held fast by an assistant, and the right lobe of the prostate is then incised towards the right tuber ischii, by passing the knife or a blunt-pointed bistoury along the blade of the instrument as a director. In this way, Martineau often enlarged the opening, repeating the incision two or three times. Crushing the stone in the bladder through the perineal wound, is a more dangerous procedure; the instrument required must be of some size and strength; its application may be attended with some injury to the bladder, which is often firmly contracted on the stone; but the crushing should be sufficiently complete to allow the passage of fragments without injury to the vesical neck; and as sources of irritation or centres of secondary calculi, the débris must be thoroughly removed by repeatedly injecting and washing out the bladder with tepid water, or sometimes a fragment of large size and angular shape may be extracted with the scoop, the finger protecting the neck of the bladder. This resource is, as Coulson remarks, an operation of lithotrity performed under most unfavourable circumstances. Yet a very large stone has thus been removed with safety; in one case, a stone weighing fourteen ounces and a half having been crushed and extracted in the lateral operation by Mayo of Winchester, with a successful result. In another case, a stone was so large as to fill the bladder; and Dr. Godman of Cincinnati, having failed to remove it by extraction or crushing, he abandoned the operation. The man recovered, and afterwards walked nearly seven hundred miles to Pennsylvania, where Dr. Given operated with the same result. Subsequently, in a third lithotomy, Dr. Physick of Philadelphia succeeded in crushing and extracting the calculus. The patient again recovered; and again walked home, but "a stone lighter than when he came." The recto-vesical, or the supra-pubic operation would be preferable to perineal crushing, in most cases of very large calculi. In a case communicated by letter to Professor Gross, the writer tells the story of his first lithotomy; that having entered the bladder, he was surprised to find the stone of such size as to occupy the whole cavity; that he enlarged the prostatic incision to the extent of nearly two inches, without being enabled to introduce the forceps, much less to expand them over the stone; nor after further incision of the prostate in all directions, could he then dislodge the calculus, around which the bladder was firmly and spasmodically contracted, any attempt at extraction only promoting severe vesical spasm, and bearing-down pains like those of labour. Under these circumstances of perplexity, he proceeded at once to open the bladder above the pubes, and was thus enabled to turn the mass out of its bed. It had a pyriform shape, weighed eight ounces, and measured nine inches and a quarter in its largest circumference. The patient made a good recovery; both wounds healing well, the man walking about his room on the eighteenth day after the double operation. But the operator adds significantly: "Mr. W. is a very tough kind of a man; I do not believe that thunder and lightning would kill him."

Fracture of the stone is apt to happen when the calculus is brittle, or soft; breaking into several sharp fragments, or squashing into a soft mortar-like mass. It occurs mostly to phosphatic calculi. This breaking-down of the stone results usually from too firm a grasp with the forceps; either lest the stone should slip away, or by pulling too high up and coming in contact with the pubic arch, or in consequence of the pressure requisite in extracting a large-sized stone. The fracture generally leaves a central stone in the blades of the forceps, which should be extracted; and the detached fragments removed by the repeated introduction of this instrument or the scoop—with the forefinger resting on the end of the bowl to keep the fragment from slipping out. The bladder should be thoroughly washed out with tepid water, injected by a strong brass syringe through a tube introduced by the wound. Detritus will probably still remain, and small fragments may be discharged through the wound for some days; then the bladder should be injected daily through a catheter passed down the urethra, and the water made to escape freely by the wound; the stream carrying with it particles of calculus. This plan should be continued until no more detritus is brought away. If the wound has healed, the fragments remaining may perhaps be washed out through the urethra, by means of an evacuator, as in lithotrity; or, after crushing them, the detritus will probably escape in the act of passing urine, from time to time.

Enveloping folds of mucous membrane are sometimes met with, the stone thus eluding the grasp of the forceps. This mechanical difficulty must be overcome by manœuvre with the forceps, or by the more direct and safe means of the finger and scoop. An insufficiently injected bladder would be more likely to present this difficulty.

Hour-glass contraction of the bladder, the stone being placed in the upper compartment, will probably necessitate recourse to the high or supra-pubic operation of lithotomy.

Rickety deformity of the pelvis, although not a common cause of difficulty in lithotomy, may present insuperable obstacles in extracting the stone. If the brim of the pelvis be narrowed in its antero-posterior diameter, the difficulty of extraction will be increased in children, owing to the high position of the bladder. Narrowing of the pubic arch, which is always narrow in children, may quite preclude extraction, or even the introduction of the forceps. These conditions should be ascertained *before* operation, and supra-pubic lithotomy performed.

The *Accidents* which sometimes happen during the lateral operation are: (1) wound of the rectum; (2) hæmorrhage, arising either from the vessels necessarily divided, or from the pudic artery or the artery of the bulb, or from certain accidental deviations of these vessels, and from the prostatic or other veins; (3) wound of the bulb; (4) missing the urethra and entering the bladder beyond the prostate; (5) penetration of the posterior part of the bladder from within its cavity.

The three first-named accidents have already been adverted to in considering the parts to be avoided in performing the lateral operation.

(1) *Wound of the rectum* is important according to its size or situation. If not discovered at the time of operation, by examination with the finger per rectum, the subsequent escape of feculent matter through the perineal wound, and of urine by the bowel, will plainly declare the lesion. The accident is more likely to occur in old persons, as Deschamps observed—the rectum

being dilated, and even wrapped around the prostate on either side. A small puncture, low down near the anus, may be left to itself; a little feculent fluid escapes from the perineal wound for some days, along with the urine; but as granulation closes up, this ceases, and the urine is transmitted through the urethra. This occurred in one of my own cases. A larger-sized aperture, or when situated higher up the bowel, had better be dealt with at once, and in the same way as fistula in ano. The bowel should be laid open into the perineal wound, by an incision from the accidental aperture downwards through the sphincter ani, so as to form one cavity. Granulation from the bottom may then restore the continuity of the bowel. Otherwise a recto-vesical fistulous communication will remain. The rectum has been wounded occasionally in lithotomy by operators of the largest experience; Cheselden acknowledging to this accident having occurred twice in his own practice, and Deschamps four times. Indeed, there are few lithotomists, I believe, who could not remember some such touches with the knife. The escape of fæcal matter from the perineal wound at a *later* period, sometimes occurs from sloughing of the bowel; in consequence, perhaps, of contusion produced by the forcible extraction of a large stone, or as the result of diffuse inflammation of the wound. In a case which Professor Gross relates from his own practice, this sloughing communication occurred in four days; in another instance, not until the twelfth day, as recorded in the "Med. Chir. Trans.," vol. xi., p. 67. The first-mentioned case resulted in a spontaneous cure, the fistulous opening having closed entirely after the lapse of some months; and in the latter case, the same happy issue was probably thus obtained.

(2) *Hæmorrhage* must be managed on ordinary principles; by ligature or torsion of any distinctly bleeding artery that may be accessible; or by pressure. The artery of the bulb is the principal source of serious, or even fatal hæmorrhage; and so also would be the internal pudic, as it can scarcely retract within the obturator fascia overlaying it; but this vessel is well protected under cover of the ramus of the ischium. Either vessel is best secured by compression; ligature being inapplicable in most cases, as the vessels cannot thus be reached. Compression is applied most effectually by means of digital pressure; provided the bleeding vessel can be commanded with the finger, and relays of assistants are at hand. In the course of fourteen or twenty-four hours, according to cases related by South and Brodie, continued digital pressure has succeeded in permanently stopping hæmorrhage from these vessels. The ramus of the bone offers an excellent counter-resistance to the finger. Ligature has been applied to the internal pudic by Sir B. Brodie, and by Dr. Physick, of America; the former Surgeon using a flexible silver needle; and more effective instruments are found in Keith's tenaculum, which can be unscrewed from the handle and left attached to the artery; or Gross's artery-compressor is available without the application of a ligature, and detached in like manner. *Oozing* hæmorrhage, of a persistent character, may be effectually arrested by injecting ice-cold water, or plugging the perineal wound.

This is precisely the condition in which Liston's gum-elastic tube may be used with advantage, while free vent also will thus be given to the urine. The track of the wound is plugged with dossils of lint around the tube; or more conveniently, by pieces of sponge introduced into a conical bag of oiled silk attached to the tube, as devised by Mr. Hilton, or the lithotomy-tube constructed by Messrs. Matthews, with syringe for the injection of water, may be used (Fig. 28). Liston's tube is kept free of coagula by the occasional introduction of an oiled feather. *Venous* hæmorrhage, proceeding chiefly from the prostatic plexus of veins, may be arrested in like manner. Hilton's contrivance has here proved very successful. A case is related in the *Medical Times*, 1855. Sir B. Brodie lost a patient within a few hours after operation, from venous hæmorrhage; every effort having been made in vain to arrest it. *Retrocedent* hæmorrhage, the blood, arterial or venous,

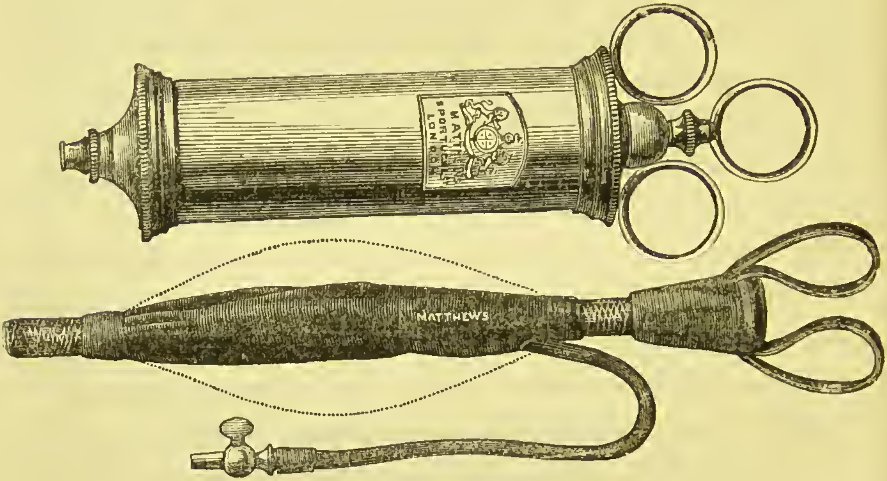


FIG. 28.

passing back into the bladder, sometimes occurs, and to an alarming extent. Bloody urine escapes by the wound, but the bladder becomes distended; there is dulness on percussion above the pubes, and the patient becomes faint. Injections of cold water should be used to wash out the bladder; and ligature or plugging applied, according to the nature and source of the hæmorrhage.

(3) *Wound of the bulb* is an accident of no serious consequence. This opinion was held by Mr. Skey, and certainly it would seem to be confirmed by the frequency with which the bulb has been wounded with impunity. But the accident has been known to induce phlebitis and pyæmia.

In connection with this accident may be mentioned the liability to some extravasation of blood into the cellular texture of the scrotum; presenting a dark plum-coloured appearance, as if the integument were about to mortify. The blood, however, is slowly absorbed. This mishap arises from opening the membranous urethra anteriorly, instead of more deeply, in front of the prostate; and the same misdirection of the knife may wound the bulb. The urine will be found to trickle from the upper angle of the perineal wound.

(4) *Missing the urethra and entering the bladder beyond the prostate,* allows of infiltration of urine into the pelvic cellular tissue. Diffuse inflammation and death will almost necessarily follow. Yet this fatal accident has occurred, once in a way, to the most skilled lithotomists. To avoid it, the nail of the left forefinger should be lodged fairly in the groove of the staff, before planting the point of the knife, over the nail.

(5) *Penetration of the posterior part of the bladder,* is liable to occur from passing the knife too deeply along the groove of the staff; the point may slip out and penetrate the posterior wall of the bladder. Hence the advantage of the button-headed bistoury. An insufficiently injected bladder would be more exposed to this accident. I have never yet known it to happen; though I have heard of such a case.

Perforation of the upper fundus of the bladder with the point of the *staff.*—This accident occurred twice in the hands of Sir H. Thompson; and the liability is referred to an occasional softening and attenuation of the coats, with perhaps a contracted state of the bladder; and the staff having an unnecessarily long curve. The free use of the forceps might inflict similar injury, under the same circumstances. Rapidly fatal peritonitis, from extravasation of urine, ensued in both cases ("Med. Chir. Trans.," vol. lxi.).

In *children,* the accidents specially incident to lateral lithotomy have been fully considered in describing the operation as performed before puberty or at an earlier period of life.

AFTER-TREATMENT.—When no accident has occurred during the operation, the treatment after lateral lithotomy is simple. The patient is placed on his back in bed, with his legs apart and the knees somewhat raised on pillows. The urine will thus drain away through the wound, as it is secreted; preventing the chance of urinary infiltration. A draw-sheet covered with Mackintosh cloth, having been previously placed under the buttocks, will enable the nurse to keep the patient clean and dry without altering his position. No dressing is required; a flat sponge or small spittoon-pot is placed under the wound against the nates to catch the urine as it drops. *If* Liston's gum-elastic tube has been passed up the wound into the bladder, and there retained by perineal tapes, this channel can be kept free from coagula and open for the distillation of the urine, by occasionally introducing an oiled feather. When I was a student, this precaution was observed so diligently, that the dresser in attendance sat by the patient's bedside, the night after operation, for the purpose of thus freeing the tube. It was retained for about twenty-four hours, in a child; and about forty-eight hours, in an adult. By that time its retention was thought unnecessary; the sides of the wound having become glazed over with lymph, whereby the risk of infiltration will have ceased. As soon as a free vent for the urine is established through the perineal wound, the patient need not be restrained to the dorsal position, but may turn over on either side. An opiate should be given, and repeated when necessary, to secure sleep or at least quiescence; and diluent drinks allowed plentifully, with light fluid food, as milk, arrow-root, or beaf-tea, during the first three or four days. In an elderly person, it may be requisite to soon have recourse to stimulants. The bowels having been well emptied before operation, need not be relieved for four or five days, in order not to disturb the bladder. Then, a mild oleaginous enema may suffice to clear the rectum. *Vesical spasm* has occurred in my experience; the symptoms being a plunging sensation at the neck of the bladder, with acute pain at the end of the penis. The attack recurs at intervals, and is unaccompanied with any pain on pressure above the pubes, or when the bladder or prostate is tilted with the finger in the rectum. This painful spasmodic affection may thus be distinguished from the uninterrupted pain consequent on pelvic cellulitis around the neck of the bladder—a much more perilous event. The spasm arises from a tympanitic state of the abdomen, forcing the bladder downwards. Escape of flatus from the bowels has soon afforded marked relief. But the same suffering may be produced by clotted blood in the prostatic urethra. Then, by passing an elastic catheter up the wound, or through the urethra, or in both ways to reach and displace the clot, will also relieve the symptoms. *Retention* of urine sometimes occurs, and must be instantly relieved by passing a gum-elastic catheter or the finger up the wound to the neck of the bladder. Warm fomentations and opiates will then allay pain and irritation. About the fourth or fifth day, the urine may suddenly cease to escape through the wound, and be discharged through the urethra;—the patient "wets," as nurses are accustomed to understand it. This, however, seems due to a temporary turgescence in the wound, resulting from inflammatory swelling which occludes the outlet; subsiding in a day or two, the urine again escapes by the wound. The same temporary discharge of urine through the natural passage may happen at an earlier period,—within twenty-four hours after operation. It is not at all a favourable sign. Urine having again returned through the wound, the quantity gradually diminishes during contraction and granulation; a portion passes permanently by the urethra in a week or ten days, and the wound closes about the end of a fortnight to three weeks. The urine itself, at first bloody, gradually assumes a brownish colour, as it becomes clearer. Vesical mucus may also be deposited in the urine; and a sort of fibrinous matter I have noticed sometimes floating downwards from the surface of the fluid, collected in a vessel. This latter appearance ceases as the wound heals.

The favourable course of a case *mainly* depends upon the limited extent of the prostatic incision; but more especially, upon the absence of contusion or laceration in extraction of the stone. The size of the calculus, therefore, materially affects the progress of the case, and in favour of a small stone. In the case of a gentleman, aged sixty-eight—sent to me by Dr. Scott, of Southampton —I removed two stones by the lateral operation, each stone being of moderate size; the extreme hardness of the calculi, consisting of uric acid, and the vesical irritability, having determined me to perform lithotomy rather than lithotrity. After the operation, urine passed partly by the urethra, as well as by the wound, from the first day; and on the seventh day, the whole came suddenly in an ejected stream through the urethra,—without any return through the perineal wound, which soon closed entirely.

The state of the urine seems to regulate the period when natural micturition will be established; as the urine becomes clear, or at least free of blood, this change indicates that the prostatic incision is closing.

The perineal wound is usually soundly healed in from thirty to forty days. In the case of a large mulberry calculus which I removed from a man sixty-five years of age, the patient returned sound to Hastings, at the end of a month. Another man, aged forty-nine, was convalescent and returned home on the eighteenth day,—by his own urgent request. But although the wound may have healed at an unusually early period, it is not desirable that the patient should resume his occupation before firm consolidation has taken place. There have been instances in which the neck of the bladder has given way, and a temporarily most successful issue thus converted into a fatal result. Phosphatic calculi generally entail the longest period for recovery after operation.

Morbid conditions of the wound, as that of sloughing or suppuration, must be treated accordingly.

Sometimes the wound becomes overlaid with white phosphatic deposit from the urine, which thus prevents the granulating surfaces uniting. This coating cannot be wiped off; but it may be removed by a weak solution of the dilute nitric acid, in water, used by means of a glass syringe.

Secondary hæmorrhage not unfrequently occurs; apparently, as Sir B. Brodie suggests, from the detachment of a slough. Compression of the bleeding vessels will here prove more effectual than ligature.

Once in a way, the patient may be troubled with *orchitis*, commencing as epididymitis, about the end of the second week. I have only known this to happen in one case, and then on the eighteenth day. It may arise from some damage done to the ejaculatory ducts in cutting or extraction; but it may also depend on an irritant acid state of the urine passing through the recently healed prostatic urethra. This was undoubtedly the explanation in the case referred to; for the right testicle was attacked, and the inflammatory affection subsided as soon as the hyperacidity of the urine was corrected by free doses of bicarbonate of soda, which also controlled the heartburn and dyspeptic symptoms concurrent with the attack.

Urinary fistula sometimes remains, with incontinence of urine, temporary or permanent. This result is met with mostly in children, and it generally ceases as age advances. The fistulous tract may perhaps be closed by occasionally passing a probe coated with nitrate of silver, or by the galvanic-wire cautery. Contraction will sometimes be aided by keeping an elastic catheter in the bladder, to divert the escape of urine into the urethral passage. *Incontinence* alone may result, particularly in childhood, if the patient be allowed to get up too soon, before the sphincter of the bladder has recovered its tone. *Impotency* is a more rare consequence of the lateral operation from wound or injury involving the ejaculatory ducts in the substance of the prostate. *Fæcal fistula* may issue from a wound of the rectum; or from bruising of the bowel, either by a forcible use of the finger in the act of protecting it, or during extraction of the stone.

After lithotomy, the symptoms of stone in the bladder cease. When the calculus originated in the kidney, and was of such a nature—usually uric acid, urates, or oxalate of lime, as would indicate no previous cystitis—the bladder returns to a healthy state, the cause of irritation having been removed. When, however, the stone was of vesical origin, from pre-existing cystitis, as in the case of phosphatic calculi, vesical irritability remains, even although the other and more peculiar symptoms of stone in the bladder cease after operation.

I pass on to graver considerations in the history of lateral lithotomy; and some of which will be found to determine the question of operation in favour of its modern rival—lithotrity.

The principal *causes of death* are: (1) Age; (2) Large Calculus and Pelvic cellulitis; (3) Disease of the Kidneys; (4) Hæmorrhage; (5) Shock; (6) Cystitis; (7) Ulceration of the Prostate; (8) Peritonitis; (9) Pyæmia. To which may be added, Erysipelas and Tetanus, as accidental and quite exceptional causes.

(1) *Age* has a remarkable relation to the mortality after lithotomy. The lateral operation is rarely fatal in childhood; a dangerous operation in middle life; and a perilous or fatal operation in old age. This operation has been found to be four times as fatal in adults as in children, at the Norwich and Norfolk Hospital. Cheselden cut 213 cases; he lost only 3 patients out of 105 under ten years of age, or 1 in 35; but of 14 above fifty years, 6 died. In Martineau's famous series of 84 cases, with only 2 deaths—34 patients were under fifteen years, only 12 were beyond sixty years. Of the cases recorded by Mr. South (in Chelius) as having been operated on at St. Thomas's Hospital during a period of twenty-three years, the mortality, at ten years old, was but 1 in 58. Coulson's table of 2,972 cases shows an increasing mortality at each successive decennial period: under ten years, it is 1 in 13; it thence gradually rises, after ten to eighty

years—to 1 in 9, 1 in 6, 1 in 5, 1 in 4, 1 in 3·65, 1 in 3·23, 1 in 2·71. The mortality at *all ages,* rates at 1 in 9, according to the St. Thomas's table of 125 cases where the age was stated; but in 1,827 cases, collected by Sir H. Thompson from the Metropolitan and Provincial Hospitals, the average mortality was higher—nearly 1 in 8; and in Coulson's general table of 6,505 cases, male and female, the average mortality rises still higher—to 1 in 6·56, or about 2 in every 13 cases.

But, while admitting the guidance of these general results in determining the probability of recovery after lithotomy, according to the age of the patient, the Surgeon's judgment should not be fettered by this consideration; the operation having proved successful at the most advanced period of senility, as well as in the earliest infancy. As extreme ages, in either direction, the following instances may be mentioned:—So soon after birth as ten weeks, the operation was performed by Civiale; in two cases at twelve months, by Mr. Keate; in one at sixteen months, by Mr. Key; in one at eighteen months, by John Hunter; and in one at twenty months, by Mr. South. Thus comprising six cases of lithotomy in infants from only a few weeks old to under two years of age. On the other hand, not to include cases of successful lithotomy betwen the ages of seventy and eighty years, among octogenarians may be mentioned a man of eighty-two, operated on by Mr. Cline; another of eighty-five, by Mr. Attenburrow of Nottingham; a second case, at eighty-seven, by the same operator; and in the case of Chief Justice Marshall, an American Judge, lithotomy was successfully performed by

Dr. Physick—the patient being at a very advanced age—and upwards of a thousand small calculi were extracted.

(2) *Size of the Stone.*—A large stone is far more dangerous than a small one, in regard to the result of operation; and the danger increases with the *size*, or *weight* of the stone. *Pelvic cellulitis* is apt to be induced, either from bruising and laceration of the neck of the bladder, produced by forcible extraction; or from infiltration of urine, consequent upon a too free prostatic incision. The former is probably the correct explanation of pelvic cellulitis; for some of the most successful lithotomists have not practised the limited prostatic incision in adults,and in children—the boundary of the prostate must almost always be overstepped by the knife; while, in the extraction of a large stone, the unyielding prostatic capsule of the recto-vesical fascia is necessarily ruptured beyond the reflexion of this fascia. Yet neither Sir W. Fergusson nor Mr. Spence have ever found urinary infiltration in any post-mortem examination after lithotomy. Crosse's table of 704 cases, in the Norwich Hospital, shows the increasing danger according to the size of the calculus, estimated by its weight. When the weight of the stone was under 1 ounce, the deaths were in proportion of 1 in 11·25 cases; from 1 to 2 ounces, 1 death in 6·61 cases; from 2 to 3 ounces, 1 in 2·18; from 3 to 4 ounces, 1 in 1·57; and from 4 to 5 ounces, 1 in 1·66 cases. The chance—observes Mr. Coulson—which a patient has for recovery after lithotomy can therefore be calculated beforehand and independent of every other consideration, from the ascertained dimensions or weight of the stone.

The symptoms of pelvic cellulitis supervene in from twenty-four to forty-eight hours. The patient complains of an aching weight and bearing down, or perhaps a smarting pain at the neck of the bladder; and pain is elicited on pressure above the pubes, especially in the left groin, and by tilting the prostate with the finger in the rectum. This vesical pain is constant, not intermittent, like spasm. At the same time, the constitutional symptoms are those of great irritation, with prostration. Rigors are followed by a dry, hot skin, a rapid, feeble, intermittent or fluttering pulse, and a dry brown tongue; then a cold clammy sweat breaks out, soddening the hands; the countenance betokens great anxiety, hiccupy respiration adds to the distress; the abdomen becomes distended and tympanitic, the perineal wound dry and gangrenous-smelling, while utter exhaustion closes the scene in from three to five days. Post-mortem examination discloses an inflamed, sloughy state of the cellular texture around the neck of the bladder, with perhaps apparently some urinary infiltration. Extension of the cellulitis backwards may have involved the adjoining peritoneum in *consequent* peritonitis.

The Surgeon will, of course, do all he can in the way of treatment—tonic and sedative, to support the patient—by beef-tea, brandy, and egg-mixture, quinine and opium; but recovery is almost hopeless, and these measures seem to be beneficial rather by letting the sufferer down more easily. Sir B. Brodie, considering the analogy between perivesical urinary infiltration, and scrotal extravasation of urine, suggested an operation, which he performed on one occasion, and with a successful result. Having introduced his left forefinger into the rectum, he passed a probe-pointed curved bistoury up the perineal wound to the left side of the neck of the bladder. Then, feeling the point through the bowel, he made an incision downwards, dividing the lower part of the rectum and sphincter; thus laying open the perineal wound and bowel into one track, for the free discharge of urine and slough. Little bleeding followed. The relief was instantaneous. It is worthy of note, that in about a month the rectum began to contract, and shortly the urine flowed by the urethra.

As arising from urinary infiltration, pelvic cellulitis would appear to be the inevitable consequence of a too free prostatic incision. Experience is conflicting in relation to this most important question, as affecting the eligibility of lithotomy for the removal of large calculi. Sir W. Fergusson and Mr. Spence have never found urinary infiltration in any post-mortem examination after lithotomy. But Sir B. Brodie relates two cases which remove any doubt as to the possibility of such an occurrence; in both, however, the urinary infiltration giving rise to perivesical cellulitis, may have been induced partly by forcible extraction, as well as by a too free prostatic incision ("Works," 1865, vol. ii. p. 615). Coulson insists on the frequency of urinary infiltration, as a cause of death; that in 90 fatal cases of lithotomy, collected by this author, by far the highest proportionate number, 22, resulted from pelvic cellulitis, thus induced. Sir H. Thompson concurs as to the frequency of pelvic cellulitis in the mortality of this operation, but he would attribute it to bruising and laceration of the neck of the bladder, rather than to the infiltration of urine.

(3) *Disease of the Kidneys.*—Chronic pyelitis, or chronic nephritis, resulting in degeneration of the kidneys with albuminous urine, may be said to represent that diseased condition of the kidneys which is most prejudicial to recovery after lithotomy.

In estimating the comparative mortality of lithotomy in *adults* and *children,* two elements seem to be in favour of the latter: — at an early period of life the kidneys are usually sound; and the stone is of small size, —thus entailing less liability to injury of the neck of the bladder, or to infiltration of urine followed by pelvic cellulitis.

In children, death generally results from some accidental violence; as the formation of a false bladder in the recto-vesical space, or disruption of the neck of the bladder from the membranous urethra. In adults, however skilfully the operation may have been performed, the state of the kidneys and the size of the stone may severally lead to a fatal issue. *Suppression of the urine* may be mentioned as a rare cause of death, the kidneys being congested, but not otherwise structurally diseased. Professor Spence had one such case.

(4) *Hæmorrhage* is liable to occur primarily or secondarily after the operation; in the latter case it takes place in about a week or ten days, or even a fortnight. Primary hæmorrhage is rarely fatal; in Liston's experience, one such case happened in 100 operations; and Coulson had not experienced dangerous hæmorrhage frequently, although out of the 90 cases of death after lithotomy, which he collected, no less than 11 occurred from hæmorrhage—primary or secondary; so also in

France, Begin affirms that it is the cause of death in 1 out of every 4 deaths, and Boyer regards hæmorrhage as one of the chief dangers of lithotomy. (5) *Shock*, as the cause of death is very uncommon; and it generally happens in old people. (6) *Cystitis* is also an unusual cause of mortality; although Boyer attributes three-fourths of the deaths, after lithotomy to this cause, or its consequences by extension to the kidney or peritoneum. Hence may be inferred the danger of performing lithotomy when cystitis is present—as must often be the case. But, while chronic inflammation of the bladder is not a favourable condition, it is probably far less unfavourable or dangerous than *acute* cystitis—the reverse of what appears to be nearer the truth in relation to lithotrity. With great vesical irritability, and deposit in the urine of blood-stained mucus, having an offensive odour, and a ropy or adhesive character, the operation is especially perilous. Two instructive cases occurred in the practice of Sir B. Brodie, where death ensued under these circumstances; although the cystotomy gave marked immediate relief ("Works," 1865, vol. ii. p. 640).

(7) *Ulceration of the Prostate* was first noticed by the same authority, as an equally unfavourable condition for the performance of lithotomy, and a cause of death soon after the operation. The ulceration is an occasional complication of chronic enlargement of the prostate, supervening in an advanced stage of the disease, and affecting that portion of the gland which projects into the neck of the bladder. Certain symptoms betoken this event. A patient has long suffered from retention of urine, owing to prostatic enlargement, but has been accustomed to

obtain relief by the daily use of the catheter. At length he suddenly begins to experience great uneasiness from the retention of even a few ounces of urine; he passes the instrument more frequently, and with temporary relief; but intense pain about the neck of the bladder, with constant and spasmodic efforts to strain off the urine, are provoked by the slightest amount of retention, and the urine itself may become streaked with blood. In the course of a short period, perhaps, the sufferer dies, worn out.

If, under these circumstances, stone in the bladder coexists with the prostatic enlargement, there will not only be the usual difficulty encountered in the operation o lithotomy, owing to the latter condition; but the ulceration of the prostate is even a more perilous omen—the patient rapidly sinking from shock, in a few minutes or hours, as occurred in the cases which Brodie relates; or death may speedily result from acute cystitis. Pre-existing disease of the kidneys, which may almost always be anticipated in connection with advanced prostatic enlargement, would of course imply the liability of uræmic poisoning, after operation.

(8) *Peritonitis,* as a consequence of cystitis, or pelvic cellulitis, may thus prove fatal; but peritonitis *per se* is a rare event, especially in adults. (9)*Pyæmia* is seldom consequent on peritonitis; but it more frequently arises from inflammation of the prostatic plexus of veins, and generally in old persons, at the end of a week or fortnight. In one case, pyæmic infection supervened as late as the fourth week, when the wound had nearly closed (Spence). Pyæmia seems to be a frequent cause of mortality, 10

deaths having thus occurred in the 90 cases referred to by Coulson.

In estimating the results of lithotomy, no Surgeon should judge from his own experience of a *limited* number of successful cases in succession. Surgeons of large experience are well aware of the fallacy of these serial cases. It has been truly said that "ten, twenty, thirty cases may succeed without interruption, and the operator flatters himself he is never to lose a patient; when two or three deaths follow in quick succession, and reduce him to a level with his neighbours, or at least within the limits of variation which the analysis of a large number of cases indicates."

Recurrence of Stone.—After the lateral operation of lithotomy, and after the median operation also, a second stone sometimes forms. The *liability* to this recurrence of calculus, and its relation to various circumstances, have been statistically investigated by Mr. C. Williams, of the Norfolk and Norwich Hospital. From the opening of the Hospital in 1772 to November, 1863, or during a period of ninety-one years, 923 cases of stone in the bladder underwent some form of lithotomy, excluding 2 cases of lithotrity; of these, 24 suffered a relapse, and underwent a second operation. The proportion of such cases to the whole number of stone-patients is 1 in 38·45. Of the 24 cases of recurrence, and a second operation of lithotomy: 19 were cured, and 5 died; 3 had stone a *third* time, 2 of which were cut and recovered, the third was deemed unfit for operation. All the patients were *males*, no instance having shown itself of recurrence in the female. In respect to *age*:—6 of the cases were under ten years of age; 2 between ten and twenty; 1 between twenty and thirty; 4 between thirty and forty; 2 between forty and fifty; 2 between fifty and sixty; and 7 between sixty and seventy. One death occurred below forty years of age; and four above that period of life. The *period* of recurrence varied from one year to twelve years; the average period was thirty-three months. *Lateral* lithotomy was performed in all the cases, excepting 8; 2 of which were cut on both occasions by the median operation, and in 4 this operation was resorted to on the second occasion. In 14, the calculi were removed in a perfect and entire condition at the first operation; while in 8, the calculi were broken in the extraction; in 1, the stones were very small and numerous; and in the remaining 1, a sacculated stone was left undetected in the bladder. The *nature* of the second calculus was not in all cases the same as that of the first; in 16, the second formation had the same composition as the first, 9 of which were phosphatic, while 7 consisted of lithic acid and the lithates; the phosphates succeeded the lithates in 5, and the oxalates in 2 cases.

MEDIAN LITHOTOMY.—The median operation of lithotomy is so named, because the incision is made in the *middle line* of the perineum. But this operation comprises two methods of procedure in relation to the *prostate;* a vertical section of the membranous urethra alone, and then dilatation of the prostate with the neck of the bladder,—"lithectasy" in the male, as it might be termed; or a vertical section of the prostate, as well as of the membranous urethra. Formerly the one was called also the "Marian operation," as having been advocated by Sanctus Marianus; and the "operation of the apparatus major," from the number of instruments employed in performing it.

The Old Marian Operation.—A grooved staff was introduced into the bladder, and the patient trussed up as for lateral lithotomy; the operator then made a vertical and nearly central incision, just to the left of the raphé, and terminating just above the anus. The *membranous urethra* was opened in the groove of the staff, and the knife being kept well in the groove, a long probe was passed by the side of the knife into the bladder. Both staff and knife were then withdrawn, leaving only the probe as a guide to the bladder. Along this instrument two iron rods or "conductors" were introduced, and by separating their handles, the prostate and neck of the bladder were dilated,—or as John Bell observes, the operator "tore open the prostate." The conductors were held aside, and "dilators" introduced to make way for the forceps, wherewith the stone was extracted. Thus, as Le Cat expressed it, the two principles of the Marian operation were; "small incision, much dilatation." Vacca revived the median operation, and practised also a vertical section of the *prostate;* thereby avoiding laceration of this part, but endangering the rectum.

Allarton's Operation.—The Marian operation had long fallen into disuse, but of late years it has been revived and slightly modified by Mr. Allarton; and with his name Median lithotomy is now generally associated, in this country; while in America, it was first brought into notice by Markoe, and afterwards advocated by Little and Walter.

The operation is performed much in the same way as by the old Marian operation, up to the introduction of the probe into the bladder; when the *forefinger*, instead of dilators, is passed along the probe, and with a semi-rotatory motion, the prostate is thus dilated. The points to be attended to are these:—the curved staff, having a central groove, is held by an assistant, firmly, perpendicularly, and hooked up against the pubes; the forefinger of the left hand is introduced into the rectum, so that its point shall steady the staff in the prostate; a straight, sharp-pointed knife is entered into the perineum, in the *middle line*, about half an inch above the anus, and carried on steadily until it strikes the groove of the staff at the membranous urethra in front of the prostate,—a depth of about one inch and a half; the knife is moved along the groove towards the bladder for a few lines deeper, and then withdrawn, at the same time cutting upwards an external incision of $\frac{3}{4}$ to $1\frac{1}{2}$ inch, according to the presumed size of the stone. A long ball-pointed probe is slid along the groove of the staff into the bladder, and the latter instrument then withdrawn, as in the old Marian operation. But the left forefinger is passed along the probe into the bladder, and used to dilate the prostate and neck, serving also as a guide to the forceps. When the stone is free, it comes at once into contact with the finger, and, if of moderate size, escapes readily into the wound on withdrawing the finger, the patient having power to strain upon and thereby facilitate the extraction of the stone with the finger.

The advantages claimed for the median, over the lateral operation, are, that the incision being strictly in the median line, no vessels are divided; the integrity of the bladder being preserved, and no chloroform given, the patient himself helps to expel the stone, without the liability of bruising the neck of the bladder, in extraction with forceps. But the risk of wounding the urethral bulb, or the rectum, must be reckoned as disadvantages incident to Median lithotomy. This operation is most suitable for *small* stones, and where lithotrity is inadmissible,—owing chiefly to irritability of the urinary organs, with perhaps a hard stone. Median lithotomy may be resorted to after lithotrity, in cases where the bladder and kidneys cannot tolerate the repeated use of the lithotrite, or irritation from the continued presence of stone-fragments. Rapid lithotrity or litholapaxy, with complete evacuation of the fragments at the time of operation, would, however, be preferable to median lithotomy, as a supplement to lithotrity, excepting where the irritability of the urinary organs is too extreme for even the rapid operation, and the stone is too large for safe lateral lithotomy.

The *results* of Median, as compared with those of Lateral Lithotomy have been generally unfavourable; a difference owing doubtless to the fact, that in median lithotomy, *without* section of the prostate, this gland and the neck of the bladder are bruised and lacerated by the dilatation,—whether with "dilators" or the "forefinger." Thus, comparing the results of 44 cases of median lithotomy with the last 44 current cases of lateral lithotomy in the Norwich Hospital, 1863, Mr. William's table shows that of the median cases, 11 died, whereas of the lateral cases, only 2 died. The results obtained by Markoe, Little, and Walter, are, however, most encouraging; showing a proportion of only 5 deaths in 139 cases, or a mortality of 1 in about 28. Of 23 cases of median lithotomy performed in Leeds, Mr. Teale reports that 20 recovered, and only 3 died. Fifteen of the operations were in adults, with a proportion of 13 recoveries, and 2 deaths. The average period of recovery—in the first-mentioned series—was seven days in favour of the median operation; thirty days instead of thirty-seven, as after the lateral operation. The weight or *size* of the calculus will much affect the result. There was no instance of recovery where the stone exceeded 3 drachms and 2 scruples,—except in one case of a stone weighing 4½ ounces, but the extraction of which was followed by sloughing of the rectum and perineum, with recto-vesical fistula. Nor was there an instance of recovery when the stone exceeded 1½ inch in its long diameter, and 1⅛ inch in its short axis,—otherwise than the exceptional case just mentioned.

Rectangular Staff Operation.—Dr. Buchanan of Glasgow introduced this procedure, which is a modification of the median operation. He used a rectangular staff, with the short branch grooved at its side. This instrument having been passed into the bladder; the angle is made to correspond in situation with the front of the prostate, the lower or grooved branch lying parallel to the rectum. The left forefinger is passed into the rectum, and a long, straight knife, held with the blade horizontal and the edge turned to the left, is made to enter the perineum opposite the angle of the staff and passed straight into and along the groove, into the bladder (Fig. 29). The membranous urethra is thus left *untouched*. In withdrawing the knife, a lateral section of the prostate is made, in its left lobe; and at the same time, an external incision downwards and outwards, round the upper and left side of the anus, to about 1¼ inch in extent.

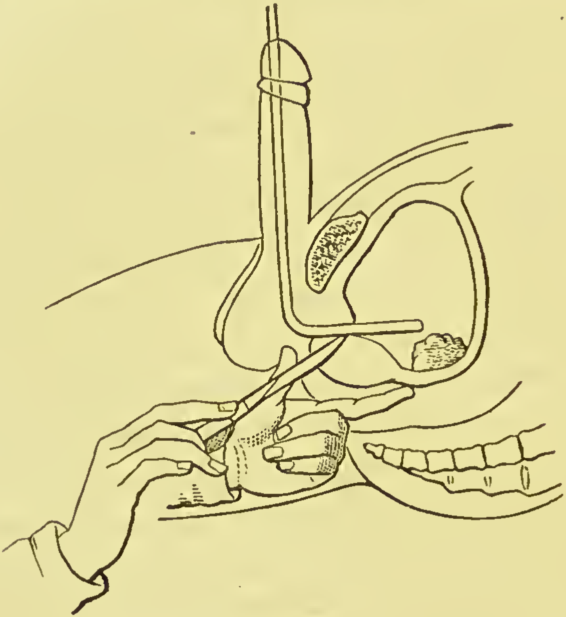


Fig. 29.

Certain features in this operation are adduced in its favour: the more direct line to the prostate, which, at the angle of the staff, is situated close to the surface of the perineum; the membranous portion of the urethra is avoided; all blood-vessels are out of the way, and consequently there is no important hæmorrhage; the rectum is less liable to be wounded; and there is less risk of deep-seated infiltration of urine.

Having thus fully considered the operation of lithotomy by the lateral and median methods, I do not attach much practical importance to the other modes of perineal lithotomy; both of them being adapted only for quite exceptional cases of large calculi, are rarely if ever practised, and for which possibly the recto-vesical operation, and certainly supra-pubic lithotomy, would be more eligible.

BILATERAL LITHOTOMY.—Dupuytren's operation consisted in making a semilunar incision, transversely, in front of the anus; the convexity of this incision being upwards, and the horns extending laterally to between the anus and the tuberosity of the ischium on either side. The tissues were carefully divided upwards to the membranous urethra, avoiding the rectum; this portion of the urethra was opened by a median incision from before backwards, with a double-edged bistoury; then, the curved double lithotome was passed along the groove of the staff into the bladder, the staff withdrawn, and the concavity of the lithotome being directed downwards, the blades were opened, and, in withdrawing the instrument, both sides of the prostate were divided obliquely downwards and outwards to the requisite extent. The extraction of the stone is then accomplished in the usual manner.

The principal advantage of this method is the facility it offers, by a free prostatic opening, for the extraction of *large* calculi; an advantage which can, however, be gained, when necessary, by bilateral section of the prostate, in the ordinary lateral operation. The risk of hæmorrhage is not less than in that method of operation; and the bilateral section, dividing both seminal ducts, endangers the emasculation of the patient.

Bilateral lithotomy has been performed chiefly by French surgeons: Roux, Sanson, Blandin, and Velpeau; and in America, by Professor Eve of Nashville University.

The results of this operation are unfavourable; 19 deaths having occurred in 85 cases, or 1 in 4½ cases.

Medio-bilateral Operation.—Civiale, in 1836, modified the median operation by his medio-bilateral procedure. It consisted of a median perineal incision, followed by a transverse section of the prostate with a straight double-bladed lithotome, which was passed into the bladder through the membranous urethra, along the groove of the staff, and the blades withdrawn open. This procedure would be suitable for the extraction of a larger stone than could be removed by the unmodified operation of median lithotomy; but in such cases, the lateral operation, with bilateral incision of the prostate, would be better adapted for the purpose.

QUADRILATERAL SECTION OF THE PROSTATE has been recommended by Vidal de Cassis, in cases of *very large* stone; no matter what the direction of external incision may be, so that it is not too small—whether oblique, vertical, transverse, or curved. The principles of this operation are, to have one large external incision, and many small internal ones. The two first sections of the prostate are made along the inferior oblique diameter of the gland on either side, which will prove sufficient when the stone is of moderate size; but, two superior oblique sections must be added, first one and then the other, when the stone is very large.

Recto-vesical Operation.—Lithotomy through the rectum is claimed by Sanson as his procedure. A grooved curved-staff having been introduced into the bladder, a vertical incision is made, corresponding to the raphé of the perineum, and dividing the sphincter ani and lower part of the rectum. Continuing the dissection, the membranous portions of the urethra and prostate are exposed. A vertical section of the prostate is then effected; either by passing the knife along the groove of the staff from before backwards, or by entering the knife behind the prostate and drawing it forwards on the finger in the groove of the staff. A portion of the base of the bladder, uncovered by peritoneum behind the prostate, may even be divided. The staff is withdrawn, the finger introduced, and the stone extracted with the forceps. Recto-vesical lithotomy was practised in this country, by Mr. Lloyd.

This operation has been recommended on the ground of its affording an easy passage for the extraction of a very large stone, and as being free from the risk of hæmorrhage. But there is a great risk of wounding the peritoneum and vesiculæ seminales; and of the subsequent occurrence of urinary infiltration, the passage of fæces into the bladder, and recto-vesical fistula. Coulson has seen cases of permanent fistulous communication. This method of lithotomy has, therefore, been discarded; and it cannot be deemed advisable even in cases of impacted calculus in the wall of the bladder.

The *results* are very unfavourable; in 185 cases thus operated on, 38 died, being a mortality of 1 in 4·86. And the subsequent condition of those who recovered is not stated. But the mortality varies according to the mode of operation; and adversely with regard to the method by incision extending *behind* the prostate. Thus, in 6 such cases by Dupuytren, 3 of the patients died from pelvic cellulitis. Then again, the risk of recto-vesical fistula depends on this incision; the 3 remaining cases of the 6 having had that result. Of 7 cases by Vacca, with division of the fundus of the bladder, 4 or 5 resulted in the same condition; and so also 3 out of 4 cases operated on by Geri.

SUPRA-PUBIC, HYPO-GASTRIC, OR HIGH OPERATION.—The *size* of the calculus, or the state of the *perineum*, especially with regard to the pelvic outlet, may render perineal lithotomy, in any form, impracticable. Under these circumstances, or other impracticable conditions, recourse may be had to supra-pubic lithotomy. In *children*, and persons below twenty years of age, the bladder stands high above the pubes, and presents a portion uncovered by peritoneum, which is freely accessible; under eight years, the peritoneal reflexion from the bladder does not generally reach lower than one inch and a half to two inches from the navel. In *old* persons, especially when emaciated, the bladder lies deep in the pelvis, behind the symphysis pubis, and would be difficult to reach; especially in a corpulent person. Chronic cystitis, resulting in a thickened state of the bladder, might also render the operation more difficult.

In order to perform supra-pubic lithotomy, the bladder must be made to rise above the pubes; and this may be accomplished either by full distension of the bladder with water, or by means of a catheter or other instrument introduced through the urethra into the bladder, so that its point shall project above the pubes. Both means are adopted to ensure a presenting part or point of the bladder in that situation. The operation consists in making a vertical incision in the middle line, above the pubes, carried upwards to about three inches in length; the linea alba is exposed, and the incision carried through the muscular wall of the abdomen and fascia transversalis; the projecting part of the bladder, uncovered by peritoneum, is sought just above the symphysis, and opened on the point of the instrument within its cavity; this incision being prolonged downwards towards the neck of the bladder with a probe-pointed bistoury, sufficiently to admit the finger. The forceps are then passed in, and the stone extracted. Accidental fracture of the calculus will present a difficulty of more consequence than when it occurs in the lateral operation; for the bladder cannot readily be washed out, and a fragment remaining, the recurrence of stone is inevitable. Various instruments have been devised wherewith to puncture the bladder from within, when reached by the incision. Thus, the *sonde-à-darde* is a puncturing instrument, combining a trocar concealed in a catheter; and this was used by Civiale. The performance of this operation is much more difficult than it would appear to be.

The *after-treatment* is simple; urinary infiltration is prevented by placing the patient on his back, and it may perhaps be advisable to introduce a gum-elastic catheter into the bladder, leaving it there for a few days until union of the wound has taken place. Formerly, it was thought necessary to close the bladder by sutures; and even to make a counter-opening through the perineum into the membranous urethra or the neck of the bladder, with the view of securing a free drain for the urine. These complications are now entirely discarded, whenever the operation is occasionally resorted to.

The *results* of this operation are, however, singularly fatal. Professor Humphry, of Cambridge, has shown that in 104 cases, 31 were fatal, mostly in consequence of peritonitis and urinary infiltration; a mortality of 1 in 3·08. The results of a large collection of cases—465—by Dr. Dulles of Philadelphia, show about the same mortality, 1 in 3·44, from the supra-pubic operation. Humphry had 1 successful case, and other Surgeons, especially M. Souberbielle, Sir Everard Home, Carpue, Kirby of Dublin, and Dr. Carpenter of Pennsylvania, have also had occasionally a successful result. But it should be remembered that the operation is had recourse to when the stone is of unusually large size, coupled with a narrow pubic arch; so that the lateral operation being inapplicable, the results of the two methods cannot fairly be compared. But Dr. Dulles's statistics would indicate a *somewhat* lower death-rate in favour of supra-pubic lithotrity, when the stone weighs more than two ounces, and upwards.

Lithotrity.—The operation of breaking-down the stone in the bladder, so as to allow of its extraction, or discharge, by fragments through the urethra, was early devised and attempted, in some way, as a substitute for the cutting operation of lithotomy. This procedure was noticed by Hippocrates amongst the Greeks; by Albucasis of the Arabian school; by Franco, Guido de Cauliaco, Hildanus, Haller, and other authors down to the end of the last century. In 1813, Gruithuisen, a Bavarian Surgeon, published two memoirs on the subject; describing his instruments for the drilling or *boring*, and the crushing the fragments, of stone in the bladder. But these isolated and imperfect attempts failed to introduce Lithotrity into the Practice of Surgery. Civiale, in 1817, then a poor student, first succeeded in drawing attention to Lithotrity, by constructing certain boring instruments, which he brought before the notice of the French Minister; and continuing his labours in subsequent years, followed by Elderton in 1819 ("Edin. Med. and Surg. Journ."), by Amussat in 1822, and Leroy d'Etiolles in 1823, this method of removing stone from the bladder acquired a recognised and established reputation.

The first operation of lithotrity in the living subject was performed by M. Civiale, January 13th, 1824. Subsequently, in this country, the first *crushing* instrument of any value was invented by Mr. Weiss, in 1824. It consisted of two blades, sliding one within the other, an under and larger, receiving or female blade, and an upper, insliding or male blade, and which was worked by a screw at the handle. With a somewhat similar instrument, in 1825, Mr. Hodgson at the Birmingham Hospital, first performed the operation of crushing stone in the bladder. Baron Heurteloup in 1830, and Costello afterwards, devised an instrument for *hammering* the stone to pieces; but the crushing procedure prevailed, and was mainly brought into practice by Sir B. Brodie. It is also worthy of record, that the fenestrum or oval slit in the under or female blade for the escape of detritus, in using the lithotrite, was suggested by Mr. Oldham, a gentleman connected with the Bank of England. Since the period referred to, lithotrity has received the special attention of Coulson, Skey, and Sir H. Thompson. More recently, Professor Bigelow, of Harvard University, U.S., has introduced his method of Litholapaxy, better known as "rapid" lithotrity, the operation being completed at a single sitting.

The *lithotrite*, or instrument for crushing the stone now in general use is Weiss's "newly invented Lithotrite," or Sir Henry Thompson's lithotrite. It enables the operator to exercise powerful, yet nicely regulated screw-pressure; its cylindrical and finely fluted handle aids the sense of touch; and the whole is a light and delicate instrument. Another form of instrument is also used by Sir William Fergusson,—a rack and key lithotrite, but which is I believe seldom employed, if not disused. I prefer a screw instrument, and especially Thompson's lithotrite, for the three reasons just stated. The fenestrum or oval aperture in the under blade is of great importance, as already stated; but Civiale's lithotrite, having no aperture in the female blade, is suitable for crushing fragments of stone. A steel sound, for detecting fragments, is also very serviceable: and an injecting apparatus will be required, consisting of large-eyed catheters of different sizes, and a strong, large-sized brass syringe, the nozzle of which fits the catheters.

Preparation of the Patient for Lithotrity.—Prior to any operation for breaking-up a stone in the bladder, it is absolutely necessary that not only should the general health be attended to, but that the bladder more especially should be brought into as quiet a condition as possible. The patient should be kept at rest, and under the management of the Surgeon, for a week or two before the operation. Freedom from vesical irritability or inflammation is more important in relation to lithotrity than to lithotomy; the former operation being perhaps an unavoidably more prolonged procedure within the bladder; or a repeated operation, and one which leaves fragments of stone behind as a continued source of irritation during their discharge. In the period of preparation, therefore, recumbency will prevent the stone lying in contact with the sensitive and more vascular vesical neck, and thus tend to bring the bladder to a quiescent state; while the urine is rendered less irritating by dietetic and medicinal measures, having reference to the nature of the calculus. An instrument may be passed occasionally, to accustom the urethra and bladder to its presence, and to ascertain the temper of the urinary organs; but the Surgeon must exercise discretion as well as gentle manipulation, with regard to any such precautionary procedure. When cystitis is accompanied with ammoniacal urine, the bladder should be washed out night and morning. But, if the kidneys be diseased, lithotrity should be postponed or abandoned.

Lithotrity is thus performed:—The patient having been placed recumbent on a bed or couch of convenient height, the pelvis should be slightly raised on an unyielding pillow so as to bring the lower fundus of the bladder in a line with the urethral orifice; or, if there be any prostatic enlargement, the pelvis should be raised from before backwards, to the height of four or six inches, so as to make the stone fall back on to the posterior wall of the bladder; the head and shoulders should be supported by pillows, or lowered, according to the inclination of the pelvis; and the legs separated and somewhat flexed. Chloroform may, or may not, be administered. Civiale and Sir B. Brodie were both averse to its anæsthetic influence, alleging that the feelings of the patient are a safe guide in two essential matters: as to whether any injury is being inflicted on the bladder, and whether the operative proceeding is continued beyond what the bladder and constitution are capable of enduring. But, assuming a due manipulative skill in using the lithotrite, the irritable state of the bladder, and a nervous, restless state of the patient, in many cases, will as often render the influence of chloroform an invaluable or indispensable adjunct in performing lithotrity. The bladder is first emptied, and then injected with tepid water until it contains about four or five ounces of fluid, in order that its cavity shall be sufficiently distended to remove the mucous membrane from the blades of the lithotrite in seizing the stone, even with the best bevelled instrument, and to make room for crushing without injuring the bladder by splintering. In old cases of stone, the bladder may be so thickened and irritable as to eject a few spoonfuls of fluid; then the injection must be repeated very slowly, and gradually, pausing occasionally until the bladder becomes accustomed to the increasing distension. Civiale, Sir B. Brodie, Coulson senr., and other lithotritists, approved of injecting the bladder; while Sir H. Thompson and other Surgeons of large experience dispense with injection, as being an unnecessary or prejudicial addition of instrumental interference, and therefore allow the urine to be retained. The latter expert lithotritist, indeed, disregards taking any special precaution as to the quantity of urine in the bladder; "never even asking a patient to hold his water beforehand, nor when he micturated last." But on no account without sufficient dilatation of the bladder should the operation be proceeded with, in the hands of the average operator. Then, the Surgeon, standing on the right side of the patient, as the most convenient position, introduces the warmed and oiled lithotrite cautiously along the urethra, drawing the penis with the left hand up the shaft, as the finger of a glove is sheathed on to the finger. The abrupt curve of the lithotrite, unlike the arched curve of a catheter, and resembling that of a sound, must be remembered as soon as the end reaches the curved portion of the urethra. By depressing the handle slowly, or letting the instrument incline by its own weight, down to a right angle with the perineum, the end of the lithotrite is brought into the direction of the canal under the pubic arch, and thence passed gently into the bladder. A slight rotatory movement with the instrument will always indicate when it has entered the bladder.

Seizure of the stone may be effected in either of two ways; by making it *fall* into the blades of the lithotrite, or by *searching* for it in a certain manner.

Sir B. Brodie recommends that the instrument should be raised, the blades opened, and that the convex extremity of the under or female blade should be rested against the lower fundus of the bladder, and gently pressed down, so as to make a conical *depression* in this situation; into which the stone falls by its own weight, or by a slight shake or jerk of the instrument with the hand. Similarly, Mr. Skey gives a smart blow with the open hand against the pelvis of the patient, a *coup*, he says, which will succeed again and again in making the stone fall into the grasp of the lithotrite. The male branch is pushed forwards to seize the stone. This manœuvre may have to be repeated several times before the stone is securely caught; the female branch remaining stationary, while the male branch is slid a little up and down alternately, until the stone is seized. Civiale recommends another method, in principle, as Sir H. Thompson observes, the reverse of the preceding. By position of the patient, the centre of the bladder and space beneath it are selected as the area of operation—*no depression* is made; contact between the walls of the bladder and the instrument is, as much as possible, avoided. The instrument is *applied* to the stone in the situation which it naturally takes, and the operator carefully avoids moving it, or any movements of concussion whatever, however slight.

The *situation* of the stone is often ascertained in *passing* the lithotrite; then the blades are inclined slightly away from the side on which the stone lies,—not to move it from its position, carrying the instrument backwards also towards the posterior wall of the bladder, while the male blade is slowly withdrawn,—not to impinge on the neck of the bladder. Turning the opened lithotrite over towards the stone, and slowly closing the blades, the stone will almost certainly be seized (Fig. 30, showing also Thompson's lithotrite in action). Most frequently the stone will be caught on the *right* side of the floor of the bladder. If no stone be felt on entering the bladder, its cavity is *explored;* first, without altering the axis of the shaft of the instrument from its central or vertical position, by simply rotating it half a turn from the vertical direction, thus inclining the open blades to the

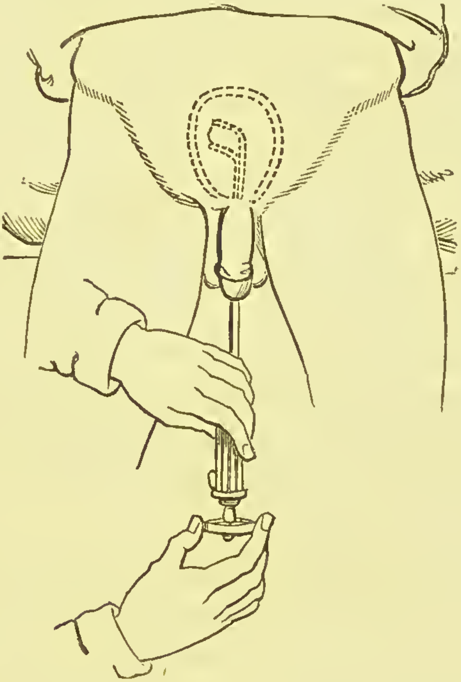


FIG. 30.

right side, and then to the left side, finding no stone; secondly, depress the handle of the instrument about half an inch, thereby raising the open blades slightly from the floor of the pelvis to a horizontal plane, and turn them to the right and left. In completing each of these movements, the blades are closed to seize the stone. These five positions—vertical, right and left incline, right and left horizontal—will explore the bladder fully, middle, right and left, and will thus almost certainly find any stone of moderate size in a healthy bladder. If the prostate be enlarged, and the stone possibly lodged in a hollow behind it; or if the stone be small, or a fragment only, the blades may be reversed or turned downwards, and the handle depressed; then, by opening and closing in the middle, or with a rotatory inclination from side to side, the stone will often be found and secured with ease. When the stone, thus sought for, is seized, the instrument is turned up again into the centre of the bladder, so that crushing may be performed free of the mucous membrane.

To meet the difficulty of *prostatic* enlargement, a modified form of lithotrite may prove serviceable; the curve of the instrument is made shorter and more abrupt, so as to mount over the projection of the prostate, especially if the middle lobe be enlarged, and the shaft is longer by two or three inches, on account of the elongation of the urethra; this twofold construction of the instrument corresponding to that of the prostatic catheter. It will be desirable also to *elevate* the pelvis, so that the stone shall fall back towards the posterior wall of the bladder; and thus further aid the manipulation of seizure.

The object of Civiale's method is strictly to avoid giving any jerk to the instrument or to the bladder; and by barely coming in *contact* with its interior, no pain or contraction of the bladder is provoked. The same object was sought to be attained by the other method, simply by *not moving* the instrument in the bladder for the purpose of exploring to ascertain the situation of the stone; the instrument, being rested, and somewhat depressed, in the lower fundus of the bladder, to make the stone fall into its blades.

Coulson seems to combine *both* these methods in using the lithotrite; a slow twirling revolution of the instrument on its own axis between the thumb and finger, without changing its central direction; and, at the same time, a gentle sliding motion of the male branch backwards and forwards to the extent of half or three-quarters of an inch—thus gently raking or traversing the floor of the bladder on either side successively.

Of these three methods of using the lithotrite, I prefer the latter.

Crushing the Stone.—When once firmly fixed between the blades of the lithotrite, the stone is to be crushed into fragments. It is raised to the centre of the bladder, so that the walls shall not be injured by the splintering of the stone. A little withdrawal and rotation of the instrument will indicate, if necessary, that the mucous membrane is not caught with the stone. Crushing may first be attempted by pressure with the *hand* alone, without the action of the screw. The *old* screw lithotrite is adapted for this double action. The female branch is held firmly by the left hand, applied to the square portion; the circular projection immediately behind is embraced between the index and middle fingers of the right hand, hooked on to it and used as a point of resistance; the expanded extremity or wheel of the male branch rests in the palm of the same hand turned upwards and forwards. In this position, by strongly and repeatedly contracting the fingers towards the palm, the male branch is slowly and cautiously driven forwards on the stone, which is distinctly felt to break down. A small stone may thus be easily crushed. When this manipulation fails, the *screw* must be brought into action. Still holding the female branch firmly with the left hand, the handle of the screw is held between the thumb and fingers of the right hand, and the screw worked gradually from left to right; thus propelling the male branch forwards on the stone. Thompson's (screw) lithotrite is readily used, the fingers and thumb of the left hand holding the round fluted portion, while the wheel is turned with the right hand, applied in a like manner. The sliding motion of the male blade of the instrument is checked by the action of a metallic button in a groove on the upper surface of the fluted cylinder.

In either mode of crushing, by hand-pressure or screw-pressure, the male branch must be sent home into the female branch, so that the blades come together. This object is known to be attained by observing that the entire length of the screw passes down the lithotrite. Then the instrument can be safely withdrawn.

The crushing should not be repeated, unless the stone is small and friable and can easily be reduced at once. The first sitting should be short, not exceeding five minutes.

Detritus, or the powder resulting from this crushing operation, can be removed from the bladder, or allowed to escape through the urethra. For the former purpose, the bladder should be washed out with tepid water. Clover's lithotritic injection-apparatus consists of a series of evacuating catheters, with an india-rubber bottle, the nozzle of which fits the opening in the stem of the instrument. On introducing the evacuator, any urine, or previous injection, flows out, carrying with it some detritus. By repeating the injection three or four times, the fluid drawn off at last ceases to contain any detritus. But the elastic suction-bottle, or aspirator, with stop-cock and catheter—as also devised by Mr. Clover—answers more effectually. This instrument is provided with a glass balloon, between the catheter and bottle, and into which the débris may be seen to fall. Before withdrawing the catheter, care must be taken that there is no fragment lodged in the eye, which might lacerate the urethra. The last return stream of water should be seen to pass freely, or a stylet had better be passed down to the eye, to make sure of this opening. Civiale was accustomed to wash out the bladder; in this particular, Sir. H. Thompson's *former* method of lithotrity (by repeated sittings) differed from that of the great original lithotritist. The powdered stone was expelled in the passage of urine; excepting when the bladder was atonied, or the vesical orifice was obstructed by an enlarged prostate.

After-treatment.—The patient should lie in bed, recumbent, for twenty-four hours, and not be allowed to stand or stoop forwards in passing water, lest fragments might fall against or lodge on the neck of the bladder, greatly increasing the risk of irritation. Diluent drinks will promote the discharge of the detritus. In elderly persons with enlarged prostate, the discharge of fragments is impeded, and Sir B. Brodie recommends that the bladder should be washed out daily.

Subsequent sittings will be required to crush the fragments; unless in the case of a small stone, when the operation can be completed on the first occasion. Intervals of from three days to a week should elapse; when the operation may perhaps be prolonged to ten minutes at a time, as the bladder becomes accustomed to the instrument, or its irritability subsides with the gradual removal of the calculus. Generally from three to six sittings must be allowed, before all the fragments can be safely crushed.

In performing these after-crushings, Civiale's lithotrite with no slit in the female blade, or the "scoop-lithotrite," with a small aperture at the angle of the female or scoop-blade, is a very serviceable instrument for breaking down fragments. Fragments of rather large size may thus also be extracted through the urethra. Having seized a fragment, the size of which may be estimated by observing the separation of the blades as indicated by the length of screw exposed at the handle of the instrument, the fragment is drawn to the neck of the bladder; when by a sort of slight pulling jerk with the instrument, the practicability of easily extracting it through the urethra can be ascertained. The bladder is washed out, to remove smaller particles. This procedure of fragment-extraction I have seen practised by Sir W. Fergusson. It is far preferable, however, to crush all fragments, and allow the powdered detritus only to escape per urethram; according to the method Sir H. Thompson *formerly* practised.

A *final* exploration of the bladder is made to determine the complete removal of every fragment; any one remaining portion would form the nucleus of another calculus. Civiale's method of exploration consists in sounding the bladder, moderately full, with the patient standing, and while the urine or tepid water injection is flowing away, thus to excite the contractile action of the bladder, in order to bring any fragment more readily within reach of the instrument. This procedure having failed, a small lithoclast is introduced, and rotated slowly in the bladder, while the injection passes out through the central channel of the instrument, the blades being opened to catch the fragment. Thus, in the use of either instrument, the fragment is made to seek the evacuator, instead of the instrument finding the fragment. Unless there be an encysted bladder, or an enlarged prostate, such exploration usually proves successful. In the latter case, the short-curved lithotrite should be used, with the blades reversed downwards into the receptacle behind the prostate. The persistence of symptoms, especially after riding or walking some distance, would indicate the continued presence of some portion of the stone.

Certain *Difficulties* are liable to occur in the performance of lithotrity. They may be sufficiently anticipated and overcome by due attention to the directions given respecting the operation. Excessive Sensibility and Irritability of the bladder, and Enlargement of the Prostate, may thus severally be managed. Their importance has reference to the performance of lithotrity, and to the expulsion or retention of fragments. In the one condition chloroform, followed up by quinine and opium, will overcome the difficulty in the use of instruments, and prevent the tendency to spasmodic expulsion and impaction of large fragments; the obstruction to the introduction of an instrument, presented by prostatic enlargement, may be obviated by the short-curve or beak-shape of the prostatic lithotrite, and the stone is seized in the fundus by reversing the blades downwards; the badder being washed out to prevent the retention of fragments. More prolonged recumbency is advisable after operation, in either case, lest any fragment impinge upon the vesical neck, and which is often acutely sensitive and irritable in connection with prostatic enlargement.

Encysted Calculus,—a stone lodged in a sacculus of the bladder, presents a specially difficult complication in lithotrity,—no less than in lithotomy,—with regard to seizure of the stone; but, in the former operation, the after-treatment may also be rendered difficult by the impaction of a fragment in the sacculus, a condition which led to a fatal result in a case treated by Sir B. Brodie.

Impacted Fragments of Stone in the Urethra.—In the course of lithotrity, a fragment of stone which has escaped crushing, and may have an angular form, is apt to become impacted in the urethra; an accidental source of severe irritation which almost certainly excites alarming rigors, and may induce prostatitis or urethral abscess, cystitis or orchitis, and may even provoke a nephritic attack. At the same time, crushing cannot be continued. The immediate removal of any such urethral fragment is imperative. In the prostatic urethra, a fragment may be pushed back into the bladder, by the introduction of a full-sized, open-ended catheter, or by means of urethral injection. This manipulation failing, median lithotomy should be resorted to; and the incision will then be available for the more direct escape of the remaining débris from the bladder. When lodged in the perineal portion of the urethra, external urethrotomy is the more ready and safer method of removing the fragment; rather than by extracting it with a long, slender urethral forceps. In either procedure, the urethra should be compressed behind the fragment, lest it recede into the bladder. In the penile urethra—before the scrotum, the fragment can usually be extracted with the forceps; otherwise, it should be pushed back to the perineum, and there removed by urethrotomy, an urethral incision in front of the scrotum generally resulting in a fistulous opening. The lodgment of a fragment is more likely to occur in any portion of the urethra, when the bladder is irritable or subject to spasmodic action; and when coupled perhaps with some stricture of the urethra—the impaction then being behind the seat of the obstruction. Sometimes a bit of stone is retained in the urethra, owing to spasmodic contraction, rather than by its shape and size. In all cases connected with spasm of the bladder or urethra, opium and the warm bath are most effectual in overcoming the difficulty.

The Dangers of Lithotrity are referable to the state of the bladder and kidneys, induced by the operation.

Hæmorrhage happens, sometimes, to an inconvenient amount for the free working of the instrument; though rarely to a dangerous extent. It arises from a highly congested state of the vesical mucous membrane, or possibly from the presence of some vascular growth of the bladder. But in the 115 cases operated on by Sir B. Brodie, he did not meet a single example of serious loss of blood from the urinary organs. It was, however, so copious as to necessitate immediate recourse to lithotomy, in a case operated on by Mr. Key; and a patient at the Hôtel Dieu, in 1832, died of hæmorrhage from the bladder.

Cystitis, acute, or more frequently chronic, ensues in some cases. This is usually the consequence of rough or prolonged lithotrity; although it may arise from pre-existing prostatic or vesical disease, or from the retention of a fragment. The latter causative condition is sometimes associated with an enlarged prostate, behind which the fragment lodges; but the want of expulsion commonly depends on an atonic state of the bladder. Hence, the injection of tepid water, slowly, to wash out any débris, will be appropriate, in aid of the treatment for cystitis. Failing to clear out the bladder by injection, lithotomy affords an opening for the free discharge of fragments. In 184 cases of lithotrity by Sir H. Thompson, with 12 deaths, 3 died of cystitis or pyelitis.

Epididymitis and *Orchitis* occur sometimes from lithotrity; this inflammatory affection arising partly from irritation of the neck of the bladder by rough manipulation of the instrument; but it may also proceed from the passage of fragments, and especially from the impaction of a fragment in the urethra. Subsequent crushings of the stone must be postponed pending this complication. It will be interesting to ascertain whether "rapid" lithotrity—with complete evacuation of the fragments at the time of operation, may be less liable to any contingent inflammatory affection of the genito-urinary organs.

Nephritis, or *Pyelitis*, acute or chronic, of one or both kidneys, is not unfrequently a consequence of the operation, and the cause of death. Commencing, in the acute form, with rigors, this symptom, which might announce an attack of cystitis, or the lodgment of a fragment in the urethra, is now attended with pain in the loins, followed by uræmia. In the 12 deaths just referred to, no less than 7 resulted from this cause.

Atony of the Bladder occurs chiefly in old persons. The patient enjoys too quiet a state of the bladder after operation, the urine being retained with ease for several hours, owing to the loss of expulsive power. Chronic cystitis is very apt to supervene from retention of urine, in this deceitfully tolerant state of the bladder. On the other hand, this vesical tolerance from atony permits the use of instruments, and the presence of fragments of stone, without much irritation; and the sudden emptying of an atonic bladder might induce an attack of acute cystitis.

Spasmodic retention of urine sometimes follows the operation, and it occurs mostly in combination with an atonic state of the bladder. Both are most frequent in old persons, with enlargement of the prostate. The treatment of the spasmodic retention consists in giving a warm bath and then a full dose of opium. In either case, the urine must be drawn off with a large-sized catheter, rather than allow any accumulation in the bladder.

Retention from the impaction of coagula or a fragment in the neck of the bladder must be treated by catheterism.

Suppression of Urine, with coma, is an occasional consequence of the operation, and probably depends on some previously existing latent disease of the kidneys.

The *constitutional disturbances* incident to lithotrity may be comprised under rigors, and febrile attacks, including pyæmic infection. *Rigors* not unfrequently set in immediately after the operation, especially after the first sitting; and last perhaps for some hours, terminating in perspiration. This attack is most common and severe when the operation has been prolonged, or the urethra overstretched, and not at all in proportion to the amount of pain. A full dose of opium, or a tumbler of warm brandy-and-water, as Sir B. Brodie recommended, are the best remedies; the patient lying in bed and wrapped in a blanket. Subsequent to the operation, the lodgment of a fragment in the urethra is often the cause of rigors; and the treatment for this condition must be adopted, as already explained. Irritative *fever* may ensue, which rapidly assumes a typhoid character; the pulse rising in frequency to beyond what can be distinctly counted, and becoming proportionately feeble and irregular, with a dry hot skin, and dry, harsh, brown tongue. This attack is more surely fatal than the most severe rigors. *Pyæmia* occasionally supervenes, probably in connection with suppuration as the result of damage done to the bladder. Of the 12 deaths in Sir H. Thompson's series of cases, 2 only were due to pyæmia. Pre-existing disease of the kidneys attended with albuminous urine, always tends to induce these unfavourable or fatal constitutional consequences of lithotrity. It is probable that pyæmic infection is then associated with uræmic blood-poisoning, forming that deadly compound which is known to French authors as "intoxication urineuse."

Their treatment mainly comprises the administration of opium and stimulants, with tonics, especially quinine, judiciously regulated.

Lithotrity at a Single Sitting—Rapid Lithotrity—(Litholapaxy).—The operation of lithotrity, as hitherto described, proceeds upon the assumption that the bladder is more intolerant of a prolonged instrumental manipulation than of the continued presence of stone-fragments. Hence, the rule of short and repeated crushings, for the gradual removal of a stone—say, the size of a chestnut, and of moderate hardness—which would, however, offer no more mechanical difficulty for crushing at a single sitting. And, as the responsive sensitiveness of the bladder would seem to be a safeguard against any intolerant use of the lithotrite, during even the limited period of from three to five minutes, the operation was performed generally without anæsthesia.

But the practice of lithotrity, as thus restricted in the hands of the most expert operators—Civiale, Brodie, and Thompson, was dictated by theory, rather than by fact; and the prejudice of theory, in accordance with the traditions of half a century, had retarded the advancement of experience in favour of the removal of stone by a single crushing, and complete evacuation of the detritus from the bladder. To Professor Bigelow of Boston, U.S., is due the entire credit of having almost reversed the principle, and thence practice of lithotrity; for, by a complete, although more prolonged operation—instead of by partial and repeated crushings, he proposed to at once free the bladder from the presence of stone fragments, as being a greater source of irritation than the additional use of the instruments. Lithotrity would thus become equivalent to lithotomy, by completely emptying the bladder at one operation. But, the duration of Bigelow's operation is much longer than the old method by several sittings; varying from a few minutes to half an hour, an hour and a half, or even longer; and in one case extending to three hours and three-quarters, as a third prolonged sitting, although with a successful result and recovery. Any such extreme duration of the operation, is, however, now rendered quite exceptional, by the more effectual pulverization of the stone, and the speedy evacuation of all fragments. This improvement has been gradually attained by the use of better constructed instruments, and by greater facility in their manipulation.

The observations, clinical and pathological, which induced Professor Bigelow to propose this innovation upon an established procedure, were not in themselves new, but they were first read by him in quite a new light. In his ever-memorable monograph on "Rapid Lithotrity" (1878), he thus traces the course of events, after the old operation, in favourable cases, and also when death ensues, as not unfrequently, from cystitis. "As a rule, there is," he observes, "little difficulty in the operation. The stone is readily caught and broken into fragments, of which a few are pulverized; a large-eyed catheter is then sometimes introduced; a little sand and a few bits of stone are washed out; after which the patient is kept quiet, to discharge the remainder, and await another 'sitting.' Under favourable circumstances, such an operation, lasting a few minutes, is not only simple, but, if skilfully performed, safe. On the other hand, it is not always safe. It may happen, that during the succeeding night the patient has a chill—not the chill of so-called urethral fever, which sometimes follows the mere passage of a bougie, and which is of little consequence, but one followed by other symptoms, such as tenderness in the region of the bladder, a quickened pulse, an increasing temperature, and the frequent and painful passage of urine. Then, the Surgeon vainly waits for a favourable moment to repeat his operation; it becomes too evident that the patient is seriously ill, and it is quite possible that in the course of days or weeks he may quietly succumb. An autopsy discloses a variety of lesions, some of them remote or obscure, others of more obvious origin; and among them, not the least common, an inflamed bladder, upon the floor of which angular fragments and chips of stone are resting. Such cases have been supposed to point to the necessity for extreme precaution. But, if at the first operation the bladder could have been completely disembarrassed of every particle of stone, even with the risk of irritating its lining membrane, we can hardly doubt that the relief would then have been followed by comparatively ready repair. In short, it is difficult to avoid the conviction, that in an average case, damage to the mucous membrane is as likely to result from irritation by angular fragments *added* to the injury inflicted by an operation, as from the use of instruments protracted beyond the usual time, for the entire removal of a stone, if this result can be accomplished."

Guided by these considerations, lithotrity having been emancipated from the limitation previously recognised, as to the proper duration of this procedure, other restrictions, with regard to the suitability of the stone for such operation, have since been disregarded. The more prolonged operation, at a single sitting, has already led to the removal of far larger and harder stones by crushing—involving a longer operation, than was considered justifiable under the former method of procedure; and thence a proportionate extension of lithotrity to cases which would have been relegated to lithotomy. But, in thus having extended the range of lithotrity, the instruments employed—the lithotrite and the evacuator, appropriate for Bigelow's method, are necessarily both much larger and heavier.

It is here that the *unqualified* advantage of this method is open to question. The cardinal maxim to be observed in the practice of lithotrity is the avoidance of *any* source of irritation to the bladder and urethra; and a most important consideration, therefore, is the mechanical adaptation of the instruments, in point of size and weight, to the requirements of the operation—without damaging the urinary passages. The safety of lithotrity is determined—not only by the complete evacuation of fragments, or by the more or less prolonged employment of instruments, when skilfully handled; but is influenced also by the material lightness, and small size especially of the instruments themselves. In probably the majority of cases, a stone may be crushed and completely removed from the bladder by means of the ordinary lithotrite and evacuator. But in the case of larger and perhaps harder stones than are usually subjected to lithotrity, instruments of corresponding dimensions become absolutely necessary, if that method be adopted. The Surgeon must then choose between the peril of leaving stone-fragments in the bladder—for a second or third sitting; or of completing the operation at once, by a more prolonged manipulation with such instruments. Under these circumstances much will depend on the condition of the urinary organs, chiefly with regard to the absence of inflammation of these organs. If the prolonged use of instruments, and of *larger* size than usual, would tend to provoke acute nephritis, or chronic cystitis, or entail permanent incontinence of urine—Bigelow's method of lithotrity would be unwarrantable for the removal of calculi, beyond the size and consistence that have hitherto been safely dealt with by the ordinary operation of lithotrity. The conditions for operation might even be preferable for lithotomy.

The question which is thus raised, as to the *conse-*

quences entailed by Bigelow's method of lithotrity, must be left to the results of future experience, specially directed with reference thereto. Nothing short of a larger number of cases than those in which most men have hitherto practised this operation—say, at least, 100 cases, can afford sufficiently extensive data. Professor Bigelow's cases, 14, narrated or noticed in the work already cited, as representing all that had been done by him, and other operators, up to that time, do not touch the question proposed. Sir H. Thompson's cases, 112, as mentioned in the last edition of his "Lectures," would supply a sufficient numerical basis for the purpose. But at p. 94, where the question is adverted to, this authority speaks only in a general way respecting the less frequent supervention of chronic cystitis. The history of 91 of these cases is given in the "Transactions of the International Medical Congress" (1881); but the after-consequences of operation, with regard to the state of the urinary organs, are not definitely stated; and, indeed, the single-sitting lithotrity would seem to have been performed with instruments of smaller size than Bigelow's. Sir H. Thompson, however, specially recognises the risk consequent upon using "the heavy lithotrite and the large evacuating tubes which have of late been introduced into this country;" and he further states, "that the mere splitting, for it is not dilatation, of the urethra and neck of the bladder, which sometimes follows the introduction of such instruments, has sufficed to produce symptoms often distressingly painful, sometimes obstinate in duration, occasionally fatal." ("Lectures," p. 94.) To avoid any such risk, he would recommend whatever prolongation of the procedure may be necessary, for complete crushing, as well as evacuation with *smaller instruments;* an evacuator of 15 or 16 English diameter being employed to remove the débris, instead of Bigelow's evacuator of large calibre—18 to 20 English, or 28 to 31 French size. On the other hand, the alleged advantage of such an instrument is, that evacuation can thus be completed, with incomplete crushing, *i.e.* by a less prolonged use of the lithotrite; "that it is no longer essential to pulverize the fragments, but only to comminute them." (Bigelow's "Treatise," p. 35.) The Surgeon is thus placed in this dilemma. A *large,* and perhaps hard, calculus can only be completely removed, at "one sitting," by means of large instruments —used for the purpose of coarsely crushing or comminuting the stone, and freely evacuating the fragments—whatever the consequences of *such instrumentalization* may be; or, if instruments of smaller size be employed, it is then necessary to pulverize the stone, for complete evacuation of the powdered débris, and this may involve an indefinite, and probably unwarrantable, *prolongation* of the procedure.

Duly estimating the *present* state of experience, respecting the consequences to the urinary organs, it may be unsafe to extend the undeniable advantages of Bigelow's method of "single sitting" lithotrity to calculi beyond the average size, which were formerly removed by the old method—and even then to use instruments of only a moderate size; and that stones of large size, especially when of hard consistence, had better be removed with instruments still of moderate calibre, and by "repeated sittings," according to the old method of operation.

In offering these remarks, I have avoided the terms "litholapaxy" and "rapid lithotrity." Both are inexpressive; especially the former, and the procedure cannot properly be called rapid; seeing that the single sitting is sometimes continued for an hour and a half or more, a period of longer duration than the total of the several sittings of a few minutes each. The terms "single" and "repeated" lithotrity, might be more appropriate. For the future, lithotrity should, however, be practised not in accordance with any definite and fixed line of distinction as to the number of "sittings;" but, while the Surgeon may well be encouraged by Bigelow's discovery in favour of more prolonged instrumental manipulation, to complete the operation at a single sitting, his judgment should be guided also by the pathological conditions affecting the safety of lithotrity, in determining whether one or more additional sittings may not be the more advisable procedure, in a given case. There will, I think, henceforth be every degree of rapidity practised, in completing the operation; between that by a single sitting, and the former method by several sittings.

In performing the operation of lithotrity at a single sitting, the instruments employed are of the same kind as those used in the old operation of several sittings. But the lithotrite, the aspirator, and the evacuating catheter or evacuator, are modified, in order to complete the procedure both with regard to pulverizing the whole of the stone, and emptying the bladder of all the fragments. Two lithotrites may be required, either or both being necessary in the operation. A strong lithotrite having a fully fenestrated female blade, for crushing an unusually large stone, so that the blades shall not become impacted with débris, and a smaller lithotrite, having a flat-floored female blade, and a small aperture at the angle for the escape of débris; this instrument being adapted for crushing any stone of moderate size, or large-sized fragments produced by the pulverizing action of the fenestrated instrument. The male blade of either lithotrite is also modified accordingly; in the stronger lithotrite it is deeply notched, for the production of such fragments as can pass through the fenestrum in the female blade; but in the smaller lithotrite, the male blade is finely serrated, and wedge-shaped, so as to deliver the detritus from the sides of the blade in the act of crushing. Bigelow's lithotrites are somewhat differently finished, to answer the same purposes. The instruments, as above described, and which I have found to work admirably, are made by Messrs. Weiss, and are known as their "Lithotrites A and B." The aspirator consists of an india-rubber bulb, of sufficient size to hold four or five ounces of water, with a glass-bulb receiver for stone-fragments; and this receptacle is placed at a right-angle to the current of water in working the aspirator, whereby the fragments are the more readily dropped, and seen to fall, from the return-stream out of the bladder. An evacuator, such as shall completely remove all fragments, is the only instrument peculiar to Bigelow's method of operation. This instrument—a sort of catheter—may be straight or somewhat curved at the distal end. The latter shape passes, I think, more easily into the bladder, and also evacuates best. Various sizes may be required, according to the size of the fragments, and the quantity to be evacuated. A graduated series of evacuators allows of a suitable selection—up to 25 and 31, catheter scale French; or 15 to 20, English scale. Number 15, English, will generally suffice for complete evacuation; and it is preferable to prolong the crushing, in order thus to remove a finer detritus, through an evacuator of moderate size, rather than to forcibly dilate the urethra, for the removal of larger fragments, in a somewhat shorter period of operation.

The following general directions, according to my experience, are worthy of attention:

(1) If the stone be of unusually *large* size—as previously measured—or of *hard* consistence—as denoted by the clear ring elicited on sounding—then the full fenestrated lithotrite should be used, to slice and break the stone into large fragments; and these primary fragments should be reduced to smaller fragments or detritus, by means of the non-fenestrated or crushing lithotrite. The one lithotrite could not finish the reduction; the other lithotrite could not begin this process, without the risk of impaction, or even breaking the instrument; but will effectually reduce the fragments to such detritus as can be removed by an evacuator of moderate size.

(2) An evacuator—15 or 16—having been introduced into the bladder, the aspirator, filled with water, is attached (Fig. 31). In working the apparatus, the evacuator should be kept with the aperture in the end uppermost; the return-current produced by the aspirator

will bring the fragments down towards the aperture in the evacuator, rather than draw them from beneath. As the fragments become fewer, a slight dipping of the evacuator will tend to increase the discharge.

(3) The impaction of a fragment within the aperture or canal, of the evacuator, will be indicated by the india-rubber bulb of the aspirator suddenly ceasing to expand with the return-current. Then, a more forcible and jerking compression of the bulb may eject the fragment into the bladder, and thus clear the evacuator. Should the channel be absolutely blocked, it will be necessary to withdraw the instrument, and clear with a stylet.

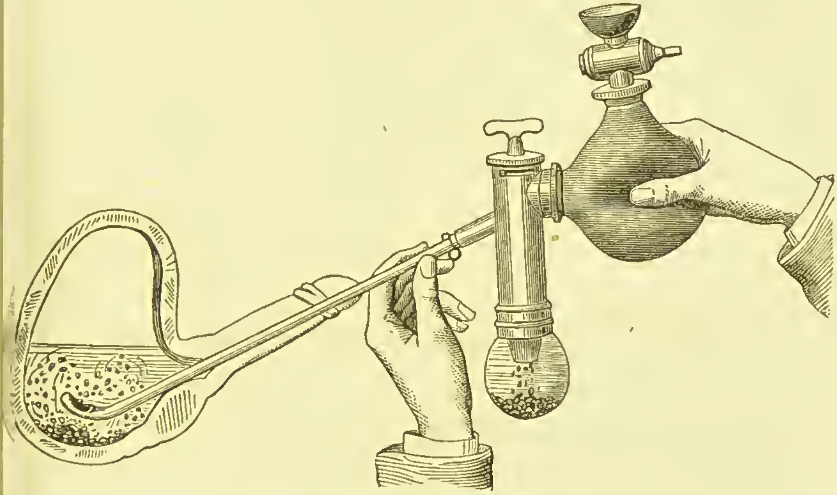


Fig. 31.

(4) In the course of operation on a large stone, it may be advantageous to crush and evacuate, alternately, two or three times; thus relieving the bladder of fragments produced by a first crushing, and making more room for working the lithotrite, when reintroduced.

(5) Towards the completion of operation, as shown by

the dropping of a fragment only now and then into the receiver, the bulb had better be worked less forcibly, with short compressive jerks, and only partly emptying the bulb; so that the little remaining detritus in the bladder, not being dispersed far from the end of the evacuator, will the more readily be caught in the return current.

(6) To detect the last fragment, hold the evacuator lightly between the thumb and forefinger of the left hand, and watch whether any slight rap against the instrument can be felt or heard, in the short return-current of the aspirator; or, two or three full compressions of the bulb may bring down a small fragment, and produce a tinkling rap on the evacuator, which could not have been detected by a less forcible return-current. The hollow tube of the evacuator seems to act like a stethoscope in the bladder; and I fancy gives more correct intimation of what is going on in that cavity, than does the latter instrument as to the movements of internal organs.

(7) In concluding the operation—when not a single particle of stone escapes into the receiver, nor a single rap against the evacuator can be produced by aspiration, and thus the detritus is apparently all removed—it may be as well to sound the bladder. For this purpose, the evacuator itself is most serviceable; by detaching it from the aspirator. Any small fragment, thus discovered, can then at once be withdrawn, by reconnecting the aspirator. Sometimes this discovery can be made more readily by the freer movements of an ordinary sound in the bladder; but this instrument does not convey the rap or click of a fragment—at least, to my ear—so

clearly as the hollow metallic evacuator. A short, flat-bladed lithotrite will enable the Surgeon to dispose of any remaining bit of stone which cannot be at once aspirated.

Lithotrity, as thus performed, may require no after-treatment. There being no more stone left as a source of vesical irritation, and no subsequent introduction of instruments, the bladder usually recovers itself speedily, and the patient is well in a week or ten days. But in adverse cases, the picture may be reversed; and the patient has to undergo the same risks which are entailed by the operation when performed gradually, at several sittings. It behoves the Surgeon, therefore, to be watchful; for he may have to encounter the dangers of severe rigors, troublesome hæmorrhage, acute or chronic cystitis, retention of urine, and pyelitis or nephritis. Under these circumstances, the treatment will be the same as after the old method of operation, and the resources of experience may be equally taxed to the utmost.

Lithotrity in Children is attended with certain *difficulties,* which as objections to this mode of operation at an early period of life, should not be overlooked. The small size of the urethra, and irritability of the bladder, are unfavourable to the free working of the lithotrite; while the dilatability of the neck of the bladder,. which is the most dependent part of the organ, and unobstructed by prostatic development, allows of the impaction of fragments, even of some size. This difficulty is increased by spasmodic contraction of the bladder, to which a child with stone is almost always subject. An anæsthetic will allay spasm during lithotrity, but the attacks recur afterwards. Peritonitis also, which rarely occurs after lithotrity in adults, must be remembered as a not uncommon consequence at an early period of life. Small and soft stones are most suitable for the operation; and it has been practised occasionally, and with success, by Civiale, and other Surgeons, both in male and female children. But the great success of lithotomy, in young subjects, has brought this operation into a far more established repute.

Results of Lithotrity, and, as compared with Lithotomy.—Unquestionably the accumulating results of experience in lithotrity lead to the conclusion that a far larger proportion of cases can fairly be submitted to this method of treatment than was formerly supposed, instead of to lithotomy. Taking the average mortality of lithotomy, at all ages, as 1 in 7, 8, or 9, lithotrity can show the far lower death-rate of 1 in 12, in 15, or in 25—only 4 per cent. This is the outcome of experience gathered from the largest collections of cases, in the hands of Civiale, Sir B. Brodie, Mr. Crichton, Sir W. Fergusson, and Sir H. Thompson. Thus, when first practised in this country, the results of Sir B. Brodie's 115 cases showed a mortality of somewhat less than 1 in 12½; whereas the mortality of lithotomy is about 1 in 7, or even as high as 1 in 4½. Civiale's cases of lithotrity in one year—1862—amounted to 45, about his annual average. Of these, 8 were partially cured; and the operation was successful in all the remaining 37, but 1. The same distinguished lithotritist states that his total mortality in 591 operations was 14 deaths, or only 1 in 42·21. But this general result has been much criticized. Sir H. Thompson's large series of cases having been more clearly recorded ("Med. Chir. Trans.," 1870), they afford more trustworthy evidence of the mortality. From an Analysis of the first 184 consecutive cases of lithotrity in the adult, it appears that the deaths, reckoning every kind of casualty following the operation, were 12, showing the recoveries to be 93 per cent.; but, omitting 5 cases of death from previous disease of the bladder or kidneys, and thus leaving 7 deaths from operation; the recoveries amounted to 96 per cent., and the mortality to only 4 per cent. Mr. Crichton has performed lithotrity in 122 cases with only 8 deaths, or less than 1 in 15. Sir W. Fergusson's experience extends to 271 cases of stone, of which number 217 were in adults; 110 were submitted to lithotomy, with a mortality of 33; whereas of 109 treated by lithotrity, only 12 died. These results are more valuable than those of Sir H. Thompson, who has published *only* his series of lithotrity cases; thus withholding the requisite *data* for a comparative estimate of the two operations, and as performed by the same operator. Mr. Charles Hawkins has collected the results of all the cases of stone in the bladder admitted into the London Hospitals (excepting the Hospital for Stone), in the years 1862-63. The total number of patients was 177, comprising 86 children and 91 adults; of the whole number it would appear that only 32 were treated by lithotrity, while 139 underwent lithotomy—the remaining 6 cases not having been submitted to either operation. Considering the relative mortality of the two operations —so highly in favour of lithotrity; the small proportion of cases submitted to this operation would scarcely seem judicious, even at that period. At the Royal Free Hospital, it is true, the 7 cases of stone in the two years, all underwent lithotomy; but then they were all cases in children.

Selection of Operation.—Lithotomy or Lithotrity. —The practical importance of a judicious selection of cases for either operation is well enforced by Civiale's statistical results, in regard to all the calculous patients on whom he operated, in one way or the other, during a period of twenty years. The total number being 838 cases of stone in the bladder; only 548 were fit cases for lithotrity; 290, or more than one-third, were not operated on by this method; and of the last 332 cases included in this list, 241 were lithotritized, leaving 91 which were considered unfit for that operation. Of the 91 cases, 28 were lithotomized, and in 8 others the two operations were combined, making a total of 36 cases subjected to lithotomy; and of which Civiale lost 18, or exactly one-half!

Bearing in mind the average relative mortality of these two operations, it should also be remembered that their safety varies considerably, according to the conditions which should regulate the Surgeon's judgment in the selection of operation.

The *conditions* in question have reference to—(1) The state of the urinary organs, and of the bladder and kidneys in particular; (2) the general health of the patient, and as connected with age; (3) the nature of the calculus—as to size, density, shape, situation, and number.

When the bladder is healthy, and the kidneys free from disease, especially with regard to albuminous urine; the general health not deteriorated; and the small stone, and friable—all the conditions concur in favour of lithotrity. The opposite conditions are, of course, unfavourable in a greater or less degree, and would indicate, proportionately, the preferable choice of lithotomy.

(1) The conditions of the *urinary organs* relate to the bladder, kidneys, prostate, and urethra. As more or less unfavourable may be mentioned, an irritable or inflammatory state of the *bladder*, or an atonic state, or an hypertrophied bladder of diminished capacity. The latter state is not unfrequently associated with extreme irritability of the bladder, thus further contracting its cavity. *Chronic* cystitis, and especially of a purulent character, is a more unfavourable condition for operation than acute cystitis; which is also comparatively rare. But the significance of cystitis in relation to lithotrity, depends very much upon whether the former be the cause or the effect of calculous formation. Moreover, a stone consequent on cystitis is usually phosphatic, and being therefore soft and friable, it yields readily to the lithotrite. An atonic state of the bladder tolerates the use of instruments, but may permit the retention of fragments. Disease of the *kidneys* of a nephritic or degenerative character, attended with morbid states of the urine, are specially unfavourable. Hence, casts of the tubes or blood in the urine, and the appearance of albumen to any amount, as persistent albuminuria, contraindicate the performance of lithotrity. Enlargement of the *prostate* is in *itself* only a mechanical objection to

the operation; the stone often being lodged in a depression behind the enlarged gland, and not easily accessible to the lithotrite. Enlargement of the middle lobe more especially, diminishes the capacity of the bladder, deepens its floor, and tends to conceal the stone in a cavity behind the gland. But an enlarged state of the prostate is often associated with more or less chronic cystitis, and occurs mostly in advanced life. Tumours in the bladder may offer considerable mechanical difficulty to lithotrity; but according to Civiale's experience, the operation will be justifiable when the tumour is small, not very sensitive, nor liable to bleed, and the stone is small and friable, so that the completion of lithotrity is not likely to be prolonged by an unusual number of sittings. Stricture of the *urethra,* or an irritable state of the passage, will obstruct the introduction of the lithotrite, and retard the discharge of detritus; and even if cured, might be attended with a further degree of chronic cystitis than would be advisable for lithotrity.

(2) The conditions of the *general health* which are unfavourable for lithotrity, cannot be clearly defined; they comprise chiefly a deranged state of the digestive organs, with loss of flesh and strength; nervous depression; and recurring febrile attacks. But in 184 consecutive cases operated on by Sir H. Thompson, in the adult, "many" of the patients were of "very feeble health and constitution" ("Med. Chir. Trans.," 1870). Disease of a vital organ, as of the heart, which might endanger life by operation, and which must perhaps prove fatal at no distant period, would of course present circumstances

that might render lithotrity, or any serious operation, unjustifiable.

Age is significant in its relation to the accompanying state of the bladder and the health of the patient. In *children*, the diameter of the urethra is small; the antero-posterior diameter of the bladder is short; the organ is irritable, and its neck is very dilatable, a peculiarity which favours the impaction of the fragments; while the indocility of the child is a great difficulty in performing lithotrity, especially when repeated sittings are necessary. This latter difficulty can be overcome by chloroform; but the undeveloped condition of the genito-urinary organs before the age of puberty, renders the operation neither an easy nor a safe one. On the other hand, lithotomy is singularly successful. Nevertheless, if lithotrity diminishes the mortality in adults, it should, as Mr. Coulson, senr., observes, have a still greater influence in reducing the comparative mortality when applied to children; in whom the urinary organs are in a healthy condition, and because the number of deaths in adults, after crushing the stone, is greatly increased by the state of the urinary organs at that period of life. Sir W. Fergusson, Mr. Curling, and other Surgeons in the London Hospitals, have performed lithotrity in children, and with not unfavourable results. In *advanced periods of life* and old age, the irritable state of the genito-urinary organs forbids lithotrity. Exceptional cases of successful results have been met with; Segalas having lithotritized 14 octogenarians, without losing 1; and 97 septuagenarians, with the loss of only 2. Of Sir H. Thompson's 184 cases, the mean age was no less than sixty-one years; 46 were seventy years, and upwards; the oldest was eighty-four years; whereas only 3 were below thirty years, and the youngest was twenty-two years old. Lithotomy, on the other hand, is very fatal in aged persons, although very successful in children.

(3) The *calculus* itself has an important influence with relation to lithotrity, more than to lithotomy. A *large* stone is unfavourable for crushing, owing to the number of fragments in the bladder and the continued discharge of detritus through the urethra, and the necessity for a more repeated performance of the operation. The bladder should be proportionately healthy, a condition not often co-existing with a large stone. It is generally admitted that a stone about the size of a *date* or *small chestnut,* and corresponding to somewhat less than an *ounce* in weight, is always suitable for lithotrity; all stones of an ounce weight, and upward, being reserved for lithotomy. A stone of this size, and weight, may be easily discovered by sounding. In Sir H. Thompson's practice, lithotrity has never proved fatal, when the stone was no larger than a small nut; but the rate of mortality rises with the increasing size of the stone, above that of a small chestnut. Bigelow's method of "rapid" lithotrity will probably lead to an extension of the operation to stones of larger size, without, perhaps, additional risk to life, or evil consequences. A *hard* stone yields sharp, angular fragments, very irritating to the bladder. A large and also hard stone may be said to contra-indicate lithotrity. But a soft or friable stone, even of large size, is not an unfavourable kind of calculus. Hence, the chemical nature of the calculus has some relation to lithotrity;

certain uric acid calculi which ring when struck with the sound, and oxalate of lime or mulberry calculus, are not readily crushed; whereas phosphatic calculi are easily broken down. Some indication as to the nature of the stone will be given by the kind of deposit in the urine, or by microscopic examination. The different consistence of the two latter kinds of calculi, in their relation to lithotrity, is, however, a consideration more than counterbalanced by the state of the urinary organs; in the oxalic acid diathesis, these organs being comparatively healthy; in regard to phosphatic calculi, equally unhealthy.

The remaining peculiarities connected with stone in the bladder, present *mechanical* difficulties chiefly, as relating to the selection of the operation—lithotrity or lithotomy. Thus, the *irregular shape* of a stone offers a difficulty in seizing it with the lithotrite. But similar difficulty is experienced in seizing with the lithotomy-forceps, and there is the additional difficulty of extraction. The *situation* of a stone may render it inaccessible; as when lodged in a pit behind an enlarged prostate, above the pubes, or encysted anywhere in the walls of the bladder. It may then be almost equally hard to get at in either operation. A *single* stone is more suited than several calculi to the performance of lithotrity, and of lithotomy also. But the time necessary or the operative procedure of crushing must be taken nto account. The presence of several calculi is not unavourable for the operation of lithotrity, provided only hey be small and soft. Civiale operated with success in a case where the bladder contained 40 calculi. The quantity of débris may, however, be more than equivalent to that of a very large calculus—an important consideration.

The *chemical composition* of calculi submitted to lithotrity has varied; all kinds of calculi having been crushed, but perhaps chiefly those of uric acid and the urates. Thus, of Sir H. Thompson's cases: 122 were uric acid, and the urates; 16 were mixed; 40 phosphatic; 4 oxalate of lime; 1 pure phosphate of lime; and 1 cystic oxide.

Besides the conditions—as relating to the urinary organs, and the general health of the patient with perhaps the nature of the calculus—which are unfavourable for lithotrity, the conscientious Surgeon will do well to take into consideration also his own fitness, as the operator.

In skilful hands, and with large experience of the operation, lithotrity may be safer than lithotomy—equally well performed. But the vast majority of Practitioners, having only a limited experience of stone in the bladder, must still continue to practise the latter operation. As an excellent lithotomist in the provinces remarked to me, "A lithotritist should always have his hand in work." In short, a good lithotomy is better for the patient than an indifferent lithotrity—wherein the operation is unnecessarily prolonged, or incompleted.

Then again, the detection of a small stone implies a practised hand in sounding; and thus an operation may not be performed, until the stone having grown to some size, its removal from the bladder would then be accomplished, by the same operator, better by cutting than by a crushing operation, and which involves the finding of the last fragment.

These considerations affecting the practice of lithotomy and lithotrity, in the hands of most Surgeons, render it doubtful whether the latter will, or should ever, entirely supersede the former operation; although I see that Sir H. Thompson, in the last edition of his "Lectures," expresses a confident opinion, that in the course of time, lithotrity will come to be the exclusive practice.

The fitness of the operator must have something to do with the *very* different mortality of the operation in the hands of even professed lithotritists; allowing for a more or less judicious selection of cases. Taking the conditions respecting the fitness of operation into account, as much affecting the resultant mortality, it would not be fair to compare the practice of lithotritists in less than a large series of cases—say 100 cases—in the hands of each operator. The relative mortality will be seen to range from 1 in 17 to as high as 1 in 5. Thus:

	CASES.	DEATHS.	
Sir H. Thompson	... 291	... 17	= 1 in 17·11.
Dr. Keith ...	... 122	... 8	= 1 in 15·25.
Mr. Crichton	... 122	... 8	= 1 in 15·25.
Sir B. Brodie	... 115	... 9	= 1 in 12·77.
Leroy ...	... 116	... 11	= 1 in 10·55.
Sir W. Fergusson	... 109	... 12	= 1 in 9·08.
Dr. Ivanchich	... 100	... 13	= 1 in 7·69.
Porta ...	... 133	... 24	= 1 in 5·54.

In concluding our comparative estimate of lithotomy and lithotrity, we must consider, not only the unfavourable conditions for the crushing operation, which can be *foreseen* by examination of the patient, and also the aptitude of the operator, according to his skill and experience, for performing this operation with even greater risk than lithotomy, under these circumstances, or of giving the patient the benefit of even the greater safety from lithotrity, in favourable cases; but it occasionally happens that the unfavourable nature of a case is discovered only *after* attempting lithotrity—thereby necessitating the subsequent recourse to lithotomy—with the additional risk entailed by this unforeseen procedure; and lastly, the relative liability to the recurrence of stone—and thence an abortive operation, must be reckoned as a most important factor in determining the comparative merits of the two methods of operation for removing stone from the bladder. But this brings us back again to the dexterity of the operator in finding the last fragment.

Lithotomy after lithotrity must be resorted to under certain exceptional circumstances. But the propriety of submitting a patient to the double risk of two operations, either of which may be of serious consequence, and which are performed almost in succession, can be sanctioned only by two orders of facts: that the one operation—lithotrity—gives rise to symptoms which would render it apparently impossible to complete this procedure, even by repeated sittings, without perilling the patient's life; and that the other operation—lithotomy—offers the only means of relief, and with less comparative danger. The unfavourable symptoms may relate to the bladder—excessive irritability, or contraction, forbidding the use of the lithotrite, especially if in addition the stone is of large size and hard consistence; or, that with constitutional symptoms of a dangerous character, the continued use of the lithotrite might provoke some pre-existing organic disease, particularly of the kidney. In either case, lithotrity should not be continued, and recourse may be had to lithotomy with advantage; the median operation being often eligible, in such cases, for the removal of fragments.

The *results* of lithotomy as a resource after lithotrity, have on the whole been encouraging. Of 28 cases by Civiale, 19 recovered, and 9 died. Of 12 cases by Souberbielle, 10 recovered; the remaining 2 deaths showing a mortality of 1 in 6, or not higher than the average death-rate of certain series of lithotomy cases, without previous lithotrity. But a more extended experience might not confirm this satisfactory estimate.

Lithotriptic Lithotomy—so designated by Malgaigne—is the combined operation of lithotrity *with* lithotomy, whether the lateral or the median operation. In con-unction with a median incision, for entering the bladder, thotrity is known as "perineal lithotrity;" but this procedure as thus described by Dolbeau is not the combination of the median operation with crushing. The xternal incision is made, as for the former operaon, in the middle line; then, the membranous rethra only is opened, and the prostatic urethra th the vesical neck is gradually dilated by means of a x-bladed dilator, and a crushing forceps introduced to the bladder to break up the stone. I know of circumstances where perineal lithotrity can be justibly substituted for ordinary urethral lithotrity—performed without the super-addition of a cutting-operation—in the first instance; and lithotrity as combined with lithotomy can only be necessary where the stone is too large for removal in the lateral operation, by bilateral section of the prostate, not to bruise the neck of the bladder in extraction. Nor have the results of perineal lithotrity hitherto been encouraging; being about double that of urethral lithotrity, and quite equal to that of lateral lithotomy—without having the advantage of the free incision for the removal and subsequent escape of fragments.

Recurrence of Stone.—After lithotrity, a recurrence of calculus in the bladder is about five times more frequent than after lithotomy. This far greater liability to a return of the enemy is owing to the difficulty of discovering the last fragment, or of ensuring its evacuation, even by Bigelow's method. As resulting from constitutional predisposition to stone-formation, recurrence must happen as often after either method of operation. In Civiale's practice relapse occurred about once in every ten cases. Of 36 patients on whom he performed lithotrity in 1860, 10 had been previously operated on, and stone had returned. In Sir H. Thompson's 184 cases, a second operation for recurrence was performed in 13 cases. In no instance, however, was an operation of lithotrity completed by lithotomy.

On the other hand, after lithotomy, as performed by many different operators—in the Hospitals of Norfolk and Norwich, Luneville, and Charité, the Hospital of Incurables, at Naples, and the Saharunpore Dispensary, India—giving a joint collection of 3,800 cases, there were only 62 instances of subsequent stone-formation, or but 1 in every 61 cases.

Recurrence must arise from some fragment having remained in the bladder, which formed the nucleus of another calculus. Hence, the practical importance of carefully searching the bladder at the last; the final exploration or sounding, to which I have already alluded. If a small fragment could escape detection in such practised hands as Civiale's, less experienced lithotritists should be far more guarded in completing a case.

Irritability of the bladder, remaining for a long time, is a not uncommon sequel of lithotrity; itself successful. This never occurs after lithotomy; the bladder having been relieved of the stone, as the source of irritation, recovers its tone completely.

Treatment.—Whether after lithotrity or lithotomy, a secondary calculus must be removed. Which kind of operation should be repeated—crushing or extraction—must be determined by the conditions already mentioned with regard to the selection of these operative procedures. As soon as symptoms of recurrence appear, careful sounding may detect the stone, while of small size; and then it can be readily removed by lithotrity. Secondary lithotomy may be performed through the track of the former wound; care being taken to avoid the rectum, which is somewhat drawn up and adherent to the membranous urethra and prostate. A condensed state of the textures might be supposed to have taken place, and thus present some obstacles to their division, and to the extraction of the stone. But, in a case operated on by Professor Spence, after an interval of fifteen years from the first operation by another Surgeon, the patient was then almost sixty years of age, and had apparently a very deep perineum; yet the left side had become more shallow, the textures being atrophied, and the prostate yielded readily to incision and dilatation with the finger—unlike the rigidity met with in age—so that the whole operation was easier of execution than usual. Other Surgeons, such as Dupuytren, and Mott, have cut patients twice. Lithotomy has been performed a third time, in the same patient, and with success: Sir A. Cooper having had a case of this kind; and so also Dr. Nathan Smith, of New York. But, on the authority of Dr. Piersig, it appears that in at least fourteen recorded cases, the same patient has been cut four times; and in four instances five times. Right lateral lithotomy might be preferred, as Liston suggested, provided the Surgeon be ambi-dextrous. Or the median operation offers an available resource in these cases, the stone probably being of small size.

PROSTATIC and URETHRAL CALCULI are more conveniently noticed in connection with Diseases of the Prostate Gland, and of the Urethra.

CALCULUS IN THE FEMALE.—Stone in the bladder is not of common occurrence in women, though not very rare. In 146 cases of stone operated on in St. Thomas's Hospital, during a period of twenty-three years, South states that 144 were males, and only 2 females, giving a proportion of 1 female to 72 males. This is greatly below the average. Crosse, at the Norwich Hospital, found the proportion to be 1 female to 19 males. In France the average was higher; 1 to 22. But in Italy, Civiale finds the average to be 1 to 18; which may probably be taken to represent the general average. Coulson, senr., puts the proportion, among those who are submitted to operation, at about 1 female to 20 males. The probability is that stone forms more frequently than it is found, in the female bladder. This seems owing to the peculiar anatomical conditions of the urethra, which facilitate the escape of a small calculus. The urethra is short, almost straight, of large size and readily dilatable, without any natural contractions in the canal; and there is no prostate gland at the neck of the bladder. Thence, a stone may form in the bladder, but more easily escape through the urethra.

In addition to the usual symptoms of stone in the male bladder, and the sure sign afforded by sounding, two *special* symptoms occur in the female. These are, bearing-down pains and pains along the urethra, and incontinence of urine—a tendency to constant dribbling or wetting. Irritability of the bladder, from any of its various causes, or a vascular urethral tumour, may give rise to similar symptoms; but sounding will determine the diagnosis.

The *consequences* of persistent calculus are sometimes also peculiar; it may be discharged through the vagina, by an ulcerative communication through the bladder and the vagina, forming a vesico-vaginal fistula; or the stone may impede the descent of the fœtal head in birth, as a rare cause of difficult parturition. I once saw an instance of this kind in the Royal Free Hospital; a woman died after childbirth, and a stone was found in the bladder, the size of a hen's egg, consisting of phosphates encrusted with carbonate of lime.

Treatment.—The various operative procedures for removing calculi from the female bladder, are of four kinds: (1) Dilatation of the urethra; (2) Dilatation, with partial slitting up, of the urethra; (3) Lithotrity; (4) Lithotomy, practised in four different ways.

Dilatation of the urethra may be accomplished *rapidly*, or *slowly;* the former method was recommended by Sir A. Cooper when the stone is *small*, and that dilatation should be accomplished in a few minutes—the method proposed by Tolet; but that when the stone is *large*, it will be better to dilate slowly and gradually from day to day, until the requisite extension is accomplished—the method suggested by Douglas. Rapid dilatation, under chloroform, is not painful, unlike the slower procedure; but according to Dupuytren's experience, and at variance with that of Mr. Coulson, senr., it is much more likely to be followed by *incontinence* of urine. Dilatation can be effected by various means; solid or flexible bougies, gum-elastic catheters, prepared sponge, or other tents; or by the cautious application of Matthews's female urethra-dilator—a three-bladed instrument, worked by a screw at the handle (Fig. 32), the speculum, or blunt gorget. After sufficient extension, a pair of forceps is introduced, and the stone extracted. Stones of considerable size and weight have been thus removed from the female bladder; notably, in a case by Coulson, the calculus weighing four ounces, and without any incontinence of urine having resulted. In one case I succeeded with forceps alone in extracting an oxalate of lime calculus, the size of an almond, which was impacted in the urethra of a young woman. The stone had been lodged there for some time, causing partial retention of urine; and when removed, its exposed surface was obviously "water-worn," by constant attrition of the stream of urine in micturition.

The *recorded results* of urethral dilatation enable the operator to more accurately estimate the comparative merits of the rapid and the slow methods of this procedure; and the balance of evidence would appear to be not unfavourable to the former method. Thus, in 28 cases of urethral dilatation which Mr. Bryant collected from the records of Guy's Hospital, 4 only were followed by any incontinence of urine, and these were cases of slow dilatation; whereas, the remaining great majority of 24 cases, without any resulting incontinence, had been submitted to rapid dilatation ("Med. Chir. Trans.," 1864). I have dilated the urethra in five minutes, by means of

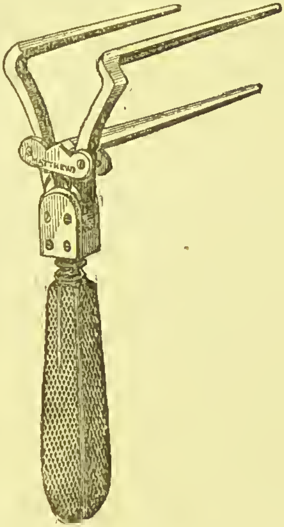


FIG. 32.

the three-pronged instrument, sufficiently to introduce my forefinger up the passage, in order to ascertain the extent of an urethral epithelioma. No incontinence followed this procedure, beyond slight temporary dribbling of urine on the third day. But slow or gradual dilatation—in from twenty-four to forty-eight hours—has yielded very safe results in the hands of Dr. Humphry; and where some of the stones were of large size. I suspect that this latter fact—as relating to the *extent* of the dilatation requisite, according to the size of the calculus, would reconcile some of the apparent differences of result attributed to the rapidity or slowness of dilatation.

Dilatation, with *partial slitting-up* of the *urethra,* is available when the former procedure has been carried to the farthest extent consistent with safety; and yet the stone is too large for extraction without thus dividing the urethra. This method is described by Ambrose Paré, who saw the elder Collot perform the operation, but it was probably originated by Dubois. A grooved staff was introduced into the urethra, and on it a small incision was made vertically *upward.* Sir B. Brodie revived this operation, and divided the urethra directly upwards under the symphysis pubis. Dilatation was then made with Weiss's instruments, to a sufficient extent for the introduction of the forceps and the extraction of the stone. The objection to the upward incision is that it necessitates extraction of the stone where the space is most restricted.

The *direction* of the incision has been varied by Surgeons: some cutting directly downwards,—as recommended by Chelius; some obliquely downwards,—as Le Dran proposed; and others sideways.

Double incision of the urethra, combined with dilatation, was proposed by Dionis; the urethral orifice being divided horizontally on both sides. The probability of incontinence of urine resulting from urethral incision, rather than from dilatation alone, seems doubtful; Surgeons of great experience holding directly opposite opinions on this important issue. After double incision, in Dionis's cases, incontinence ensued in three out of every four patients thus operated on. To obviate this result, Mr. Hey of Leeds passed a linen tent into the vagina, to keep the cut edges of the urethra together; and in a case of single incision, primary union occurred. But why not unite by fine catgut sutures?

Lithotrity is preferable to either of the above methods —urethral dilatation, or with incision combined—when the stone is of *large* size. This operation is far more easily performed in the female than in the male; and it is frequently more successful in its results; both these advantages having reference to the peculiar anatomical conditions of the urethral passage, already mentioned, coupled with the less dependent fundus of the bladder, owing to the absence of a prostate gland at the neck. But a double depression may be found, as Civiale observes, in the posterior and inferior wall of the bladder, an anterior and a posterior receptacle, formed by the projection of the neck of the uterus; and in either cavity, search must then be made for the calculus or fragments. In old women, a depression exists behind the internal opening of the urethra, wherein some difficulty may be experienced in using the lithotrite. Parturition sometimes leaves a tendency to prolapsus of the anterior wall of the vagina, carrying with it the base of the bladder; and the organ is further subject to displacement and alteration of its cavity by uterine malpositions and enlargement. *After*-treatment in the female is, however, less liable to be attended with any difficulty by the retention of fragments in the bladder, or from impaction in the urethra; detritus, and even fragments of some size readily escaping through the large and easily dilatable urethra, facilitated also by the short extent and straighter course of the passage. But spasmodic contraction of the bladder is perhaps more often encountered than in the male, relatively to the number of cases submitted to operation.

Lithotomy is also more readily performed than in the male, and it may be done in either of *four* ways.

The patient is placed under chloroform, and tied up in the position as for the operation in males; and a grooved staff is introduced into the urethra, which is hooked up perpendicularly under the symphysis pubis. A common bistoury, lithotomy-forceps, and scoop, are the only other instruments required.

(1) *Urethral* lithotomy is nothing more than incision of the urethra, carried up the passage, so as to divide also the *neck* of the bladder. Dilatation is then made sufficiently to allow of the completion of the operation, by extraction. A straight staff having been introduced into the bladder, its groove is directed downwards and outwards towards the ramus of the ischium, and the urethra divided obliquely downwards with a probe-

pointed bistoury. This incision often intersects a small portion of the anterior wall of the vagina. Chelius recommends a vertical incision directly downwards, thus dividing also the corresponding wall of the vagina. A bilateral section of the urethra has also been performed. Liston notched the neck of the bladder on both sides towards each ramus of the pubes, and then dilated for a few minutes until the finger could pass into its cavity.

The *lateral* operation, similar to that in the male, and practised originally by Frère Jacques, was revived by Dr. Buchanan, of Glasgow. A grooved staff, curved or straight, having been passed into the bladder; an incision is made on the inner side of the left nympha, from a point about half an inch above the urinary meatus, and carried obliquely downwards and outwards, parallel with the rami of the pubis and ischium. By touches with the knife, between the rami and vagina, the latter being drawn inwards and protected by the left forefinger, the staff is reached just in front of the neck of the bladder; then introducing the point of the knife into the groove, a slight urethral incision is made, inclining the blade downwards and outwards, and dividing the neck of the bladder. The opening should then be sufficiently dilated with the finger; the forceps are introduced, and the stone is extracted.

Successful results have followed this operation; the wound healing readily, and the patient having the power to retain her urine. The operation seems to be especially suitable for female *children.*

(2) *Direct* lithotomy might be performed, as suggested by Celsus. This method of "cutting on the gripe" in

women, consists in passing the fingers into the vagina, in order to press the stone forwards against the neck of the bladder, and then making a transverse incision directly on the stone between the urethra and symphysis pubis. Lisfranc endeavoured to revive this method in 1823; but it has justly fallen into disuse.

(3) *Vagino*-vesical lithotomy consists simply in making an incision through the vagina into the bladder, and thence extracting the calculus. A curved staff is passed so that its convexity shall appear in the anterior wall of the vagina, while the posterior wall is depressed with a blunt gorget or a duck-billed speculum. In this method of operation the urethra is avoided, and afterwards a female catheter is introduced along this passage into the bladder, and the edges of the vaginal incision are brought together by suture, as originally suggested by M. Coste, but first practised by Dr. Marion Sims, and adopted in this country by Mr. J. R. Lane. Vidal has thus operated in 30 cases without a single death, and Velpeau also testifies to the freedom from danger; there is generally no hæmorrhage, nor subsequent peritonitis; vesico-vaginal fistula, however, is a common result, unless the precaution be taken of closing the incision at the time of operation.

Incontinence of urine is apt to follow all these operations of lithotomy; although the last-named method is least liable to this result.

(4) *Supra-pubic* lithotomy in the female is an occasional resource; when the stone is of very large size, or the pubic arch narrowed, as from rickety deformity, or perhaps both these complications are associated.

The *solvent* treatment of Stone in the Bladder—whether by means of *chemical* solvent agents, or by *electrolysis*—will be more conveniently noticed in connection with the Medical Treatment of Urinary Calculi.

CHAPTER IV.

DISEASES OF THE PROSTATE GLAND.

THE Prostate Gland, surrounding the neck of the Bladder, and commencement of the Urethra, is a body of small size, resembling a horse-chestnut, but apt to be very troublesome. It is subject to various diseases: Inflammation, acute and chronic; Hypertrophy, or simple enlargement in advancing years; Atrophy, Cancer-growth, Cysts, Tubercular deposit, and Calculus. These diseases are identical in their nature with the same diseases of other parts; yet they are attended with symptoms peculiar to the prostate, and as affecting the bladder; which so far demand special treatment. Prostatic affections are often associated with diseases of the bladder, especially cystitis, and stone; so that, in practice, these cases are frequently found in the same patients.

PROSTATITIS, OR INFLAMMATION OF THE PROSTATE.—*Acute* prostatitis seldom occurs unconnected with inflammation of the bladder or of the urethra. A sensation of weight and fulness is experienced about the neck of the bladder, rectum, and perineum; frequent and urgent desire to pass water, pain increasing towards the close of the act, and extending down the urethra towards the glans; the stream of urine is small and ineffectual, the urine itself being sometimes blood-stained as it ceases to dribble; there is also a constant straining effort to empty the bowel, and great pain in defæcation, the motions having a somewhat flattened form; while an enlarged and exquisitely tender, and perhaps throbbing, state of the prostate is discovered on passing the finger into the rectum. The obstruction at the neck of the bladder, from further enlargement of the prostate, may soon render micturition difficult, and be followed by total retention. An attempt to pass an ordinary catheter encounters opposition, and is attended with great pain, when the instrument reaches the neck of the bladder. The constitutional disturbance is often severe; commencing with rigors, a high degree of inflammatory fever speedily ensues.

On inquiry into the causes of such an attack, prostatitis is usually found to be consequent on gonorrhœa, the inflammation having extended upwards to the prostate, or on stricture of the urethra; but it may have arisen from the rough manipulation of stricture or of lithotrity instruments; or have resulted from the irritation of a calculus, strong injections, or cauterization of the prostatic urethra. Cold and damp affecting the perineum, will also give rise to prostatitis, as by sitting on the grass in the dews of an autumn evening; and especially in gouty or rheumatic subjects. The scrofulous constitution is equally prone to this prostatic affection. As occasional causes may be mentioned: alcoholic drinks, and inordinate sexual excitement, or hard riding on horseback; when, in either case, urethritis already exists. As an idiopathic inflammation it is very rare.

It terminates in the course of a few days; either in resolution—the symptoms subsiding, accompanied perhaps with a slight urethral discharge of prostatic mucus, mixed sometimes with semen from the adjoining seminal vesicles; or suppuration takes place, with the formation of prostatic abscess; or the inflammation passes into a chronic state, with continued enlargement of the organ. During these changes, epididymitis and orchitis are liable to occur, as a secondary affection to the prostatic inflammation. When arising from gonorrhœa, or stricture with gleet, the urethral discharge ceases during the acute stage of inflammation, but returns as the prostatitis subsides, attended probably with orchitis.

Treatment.—The abstraction of blood from the perineum affords the greatest relief to acute inflammation of the prostate. Ten or twenty leeches should be applied, or cupping may be performed to the amount of six or eight ounces; followed by warm fomentations and hip baths. Pain and vesical irritability are best relieved by opiate suppositories; as of pil. saponis co., five or ten grains. But the rectum must be kept free of any fæcal accumulation, by the occasional administration of an oleaginous enema; while the febrile excitement may be subdued by antimonial salines and low diet. According to Sir B. Brodie's experience, the influence of mercurials, as by calomel taken in pills, to affect the system, will prove of the greatest benefit. In gouty cases, the acid and irritant state of the urine should be neutralized by alkaline diluent drinks. Any retention of urine will probably yield under a full dose of opium, or necessitate the use of a gum-elastic catheter from time to time. By promptly adopting this plan of treatment, the inflammation may subside, without suppuration; leaving the prostate somewhat tender, enlarged and hardened for a while; with a tendency to relapse, and some difficulty or delay of the stream in the act of passing urine.

Abscess of Prostate.—Suppuration is preceded by, perhaps, a shivering-fit, and by throbbing about the neck of the bladder or in the perineum; the rectal swelling becomes softer to the finger, and tense fluctuation may be perceptible; at length the abscess bursts into the urethra and discharges through that passage, pus appearing in the urine; or in using a catheter for the relief of retention, the prostatic abscess is burst, and a quantity of matter is drawn off through the instrument. All the agony of prostatitis, culminating in abscess, at once ceases; the sleepless and bewildered patient sometimes falling exhausted into a slumber. Usually, the abscess soon heals up; but if it remain open, it becomes a receptacle for urine, and this urinary abscess bursting into the perineum results in the formation of fistula in perineo. Sometimes the original abscess discharges through the rectum, forming an urethro-rectal fistula; and occasionally it opens into the bladder, or backward into the peritoneal pouch.

Peri-prostatic abscess occurs in not a few cases; the matter forming external to the prostate, and not within the capsule of the organ. It may be distinguished by œdematous swelling, diffused around the prostate, instead of the tense fluctuation and usually more limited and circumscribed collection of matter within the substance of the gland.

Treatment should be prompt and decided, with the view of giving vent to any formation of matter, before the abscess communicates with the urethra or the rectum. As soon, therefore, as there is any tendency to perineal swelling, manifested by brawny induration without fluctuation, an incision should be made in the middle line, about three-quarters of an inch above the anus, and cautiously deepened down to the matter; avoiding the rectum. For this purpose, the forefinger of the left hand being passed into the bowel, a long and narrow, straight, sharp-pointed bistoury is used with the edge directed upwards. The depth to which the incision must be carried will be an inch and a half to two inches, and extended upwards in the raphé sufficiently to give a fair opening. Relief is immediate, just as when an acute tonsilar abscess is set free. If no pus escapes, the tension and pain are at once relieved, and matter may issue through the wound after a warm fomentation for a few hours. Puncture per rectum might be deemed advisable when fluctuation can be distinctly felt in that situation. When the abscess has already burst into the urethra, it will be a desirable precaution to draw off the urine occasionally, by means of a well-curved elastic catheter; or even to keep the bladder empty by retaining the instrument, if it can be tolerated. Then, the instrument should be of moderate size, not to block up the abscess.

In passing the catheter, its point should be directed along the roof of the urethra, when the turn is made under the pubic arch. The constitutional treatment must of course have regard to the exhaustion consequent on the trying ordeal of prostatic abscess. Hence, the administration of quinine and the mineral acids ; and of iron with cod-liver oil, specially in scrofulous cases.

Peri-prostatic abscess must be treated in like manner, there being no practical distinction between it and prostatic abscess.

Chronic inflammation results in enlargement of the prostate ; a condition which is accompanied with frequent and painful micturition, but a less forcible stream of urine than natural, followed perhaps by a drop or two of blood ; usually also there is a clear and transparent gleety discharge, or a viscid muco-purulent matter oozes from the meatus, and the urine is milky and deposits more or less purulent matter on standing. This discharge from the urethra is significant of *Prostatorrhœa,* when accompanied with the other symptoms of chronic inflammation of the prostate. The viscid discharge comes especially after micturition, and is increased by any straining effort. Sexual intercourse is painful, and nocturnal emissions often occur. These symptoms are much aggravated by any perineal irritation, as in the passage of hardened fæces, or by riding on horseback, or prolonged walking exercise ; and also by errors of diet. The state of the prostate can be readily ascertained by examination with the finger through the rectum.

The *diagnosis* of prostatorrhœa from gonorrhœa turns mainly on the viscid character of the discharge ; and when resembling that of gleet, the fact of there having been no antecedent gonorrhœa will be distinctive. From spermatorrhœa the absence of spermatozoa in the discharge is characteristic of its different nature. From chronic hypertrophic enlargement of the prostate, chronic prostatitis may be distinguished by its painful character. In passing an instrument, the hyperæsthetic or highly sensitive state of the prostatic urethra is further significant, and all the symptoms of prostatitis are much aggravated for some time afterwards. Stone in the bladder simulates symptoms of chronic prostatic enlargement—inflammatory or hypertrophic: frequent and perhaps painful micturition being attended with blood-stained urine occasionally, and pain or irritation in the glans penis, especially after micturition, when the bladder contracts upon the sensitive prostate ; but there is delay in passing water, instead of the sudden stoppage which sometimes occurs from a stone falling over the neck of the bladder. Sounding will be absolutely diagnostic of a calculus, unless when the stone lies concealed behind the enlarged prostate, where it may escape detection.

In the *treatment* of chronic inflammation of the prostate, some benefit may be obtained from blistering the perineum, while the digestive organs must be carefully regulated, in order not to provoke the prostate by constipation or acidity of the urine ; then the iodide of potassium, with iron and quinine as tonics, may be administered with advantage. Dilute phosphoric acid, in drachm doses, with half a grain of strychnine in solution, is highly recommended by Bumstead. These medicinal measures should be reinforced by a supporting diet. The sensitive state of the prostatic urethra—in itself a troublesome affection—can often be allayed by the occasional application of nitrate of silver, in the form of an armed bougie; thus controlling the nocturnal priapism and emissions. But, as in all inflammatory affections of a chronic character, the course of treatment will have to be continued for a considerable period. Time, indeed, may be a better friend to the patient than any prolonged treatment.

Hypertrophy, or Chronic Enlargement of the Prostate.—This well-known prostatic affection is frequently met with in men after mid-life—from fifty-five to sixty years of age; never before the former period, and seldom in extreme old age. This prostatic enlargement is a natural accompaniment of advancing years; yet as an incidental pathological condition, and not a physiological change. In the majority of old men, the prostate remains of normal size; and in some, this organ is actually atrophied. It differs from chronic inflammation of the prostate, to which, after puberty, any age is liable; and it differs also in being an hypertrophied or overgrown condition of the gland.

Structural Conditions.—The dissections by Sir H. Thompson and by Dr. Messer have thrown much light on the structural alterations which constitute chronic enlargement of the prostate. The tissues of which the prostate gland consists—in its normal or anatomical structure—are: first, unstriped muscular fibre, with fibro-connective tissue, forming at least three-fourths of the prostatic body; secondly, interspersed among this structure are numerous branching glandular tubes and crypts, with their accompanying ducts. Enlargement, or hypertrophy, is generally determined by an abnormal production of the first-named elements alone; or with some of the glandular tissue interspersed, and which may be imperfectly or fully developed. More rarely, the fibro-connective-tissue element in the prostate is specially the seat of hypertrophy; and forming imbedded nodules or outgrowths.*

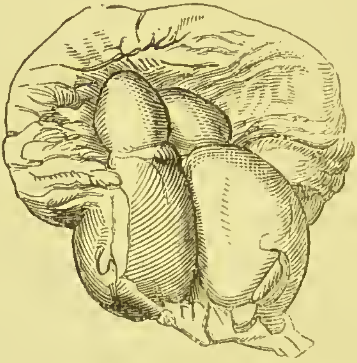


FIG. 33.—St. Bartholomew's Hosp. Mus. Enlarged prostate; longitudinal section. (Mr. Pye.)

The *parts* of the prostate thus affected may be: the two lateral lobes, which are sometimes increased to four or six times their natural weight and bulk (Fig. 33); or an outgrowth takes place from the central part of the organ, in a backward and upward direction, beneath the neck of the bladder, and behind the vesical or urethral orifice; appearing as a rounded or pyriform tumour or elevation of prostatic tissue—the enlarged "middle or third lobe," or median central hypertrophy of the prostate, at the neck of the bladder (Fig. 33); and this form of partial enlargement is the most common. Generally, however, the whole organ more or less partakes in the enlargement. Sometimes isolated tumours of prostatic tissue—*myomatous* tumours, are produced, imbedded, or as polypoid outgrowths. Consisting principally of the unstriped muscular tissue, with some portion of imperfect glandular prostatic structure, they form small, rounded bodies, varying in size from a pea to a filbert, and are sometimes completely isolated by a limiting fibrous capsule. These small imbedded tumours seem to have a relation to the containing organ, similar to fibrous tumours in the uterus. As a polypoid outgrowth, it may obstruct the prostatic portion of the urethra.

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* "Trans. Path. Soc.," vol. vii. Case by Sir H. Thompson.

The *physical* characters of the enlarged prostate are not so definite as its structural condition. In consistence it is usually firmer and harder than natural, as if the organ were enclosed within a tight or stretched envelope; sometimes it feels looser and softer than natural. The formation of numerous fibrous tumours within the prostatic substance will more especially present the former character. In external colour there is no change from the healthy state, unlike malignant enlargement. The weight and size of a simply enlarged prostate are sometimes very remarkable. Taking the average weight of a healthy prostate to be four drachms and three-quarters, the average size is—from base to apex, one inch and a quarter to one inch and a half; transversely, one inch and three-quarters, exceeding the antero-posterior diameter by a fourth or fifth; and the greatest thickness five-eighths to seven-eighths (H. Thompson). Weight is a fair index to size. The enlarged prostate reaches commonly to eight or twelve drachms, or more than double the natural weight. A prostate weighing an ounce will have attained to the size of one inch in thickness from before backwards, and two inches in a transverse direction. Three inches transversely is not uncommon, and even four inches or rather more has been attained. The weight has been known to reach to twelve ounces.

Structural *alterations* in the *prostatic urethra,* and *neck* of the *bladder.*—The vesico-urethral portion of the urethral canal undergoes certain alterations of length and direction, which tend to obstruct the passage of urine. The *prostatic* portion of the *urethra* becomes enlarged in its antero-posterior diameter, and narrowed transversely; instead of being, when distended, of nearly equal diameter both ways. In some cases, the prostatic urethra is enlarged laterally, as well as being elongated, forming an ovoid cavity. In point of length this portion of the urethra is always increased; measuring perhaps four inches from the orifice of the bladder to the membranous portion; instead of its normal length, one inch and a half. Its direction deviates from the natural passage; with enlargement of the middle lobe, the urethra rises abruptly as an angular curvature, instead of having nearly a straight line; thus presenting a complete step or "bar at the neck of the bladder"

(Fig. 34), over which an instrument must be made to pass before it will enter the cavity. Another kind of bar may form, independently of any prostatic enlargement, behind the prostate, and consisting—as Guthrie originally described it—of transverse muscular fibres, across the trigone, which have become hypertrophied. The trigone is thus narrowed laterally, and the orifices of the ureters lie nearer together; while the transverse band of muscle, as an elevated ridge, offers some obstruction to an instrument—beyond any enlargement of the middle lobe. A polypoid outgrowth from the middle lobe may act as a valve, overlapping the vesical orifice; and which, in the act of micturition, completely obstructs the passage of urine. With enlargement of either lateral lobe,

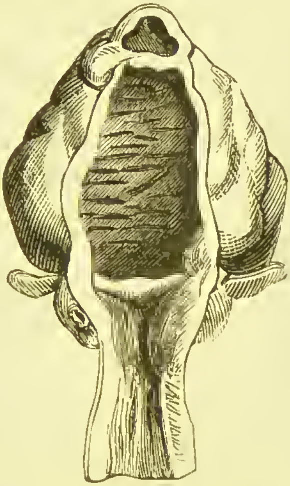
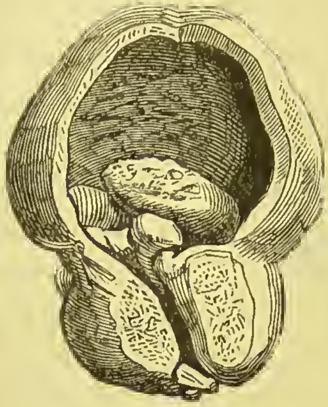


Fig. 34.—Roy. Coll. Surg. Mus., 2,489. Enlargement of middle lobe of prostate, with two folds of thickened mucous membrane connecting it with the lateral lobes; forming a transverse bar at, or around, the posterior half of the urethral orifice. The patient was eighty years old, and had suffered many years with difficulty and frequent desire to pass water. Two attacks of retention of urine. Catheterism three or more times a day for the last three years of life, when death occurred from some intestinal disease. (Sir E. Home.)

bulging inwards on the canal, the lateral direction of the prostatic urethra is changed; curving to the opposite side, in this form of enlargement. (Figs. 35 and 36.) The *vesico-urethral orifice* shares in these changes of shape; becoming crescentic (Fig. 37) with the convexity turned upwards, when the middle lobe is enlarged; or turned to either side, as the enlargement of the lateral lobe on the opposite side encroaches on the prostatic urethra.



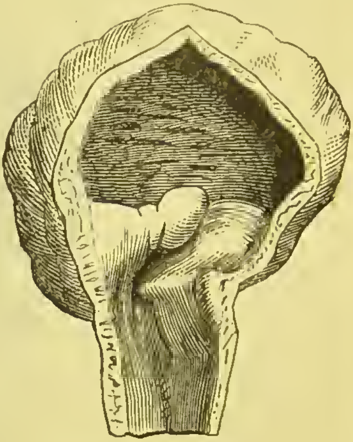


Fig. 35.—Roy. Coll. Surg. Mus., 2,479. Enlargement of the *right* lateral lobe of the prostate, as a convex projection into the urethra; with nipple-form projection of the middle lobe, directed from the opposite side. Deepening of the prostatic urethra, and *curvature;* its *concavity* being turned towards the convex lateral lobe. (Sir W. Blizard.).

Fig. 36.—Roy. Coll. Surg. Mus., 2,501. Enlargement of the *left* lateral lobe of the prostate, as a convex or angular projection into the urethra; with nipple-form projection of the middle lobe, directed from the opposite side. Deepening of the prostatic urethra, and *curvature;* its *concavity* being turned towards the convex lateral lobe. (Liston.) In this and the previous case, the curvature of the prostatic urethra is increased by the enlargement of the middle lobe having a direction from the *opposite* side.

The general result of these alterations in the urethral canal, is this: as a whole, it becomes elongated and more curved; while the prostatic portion and vesical orifice may have also a tortuous course, somewhat like an italic *S*.

Various causes have been assigned for chronic enlargement or hypertrophy of the prostate.

All circumstances which tend to induce afflux of blood to this part, may be productive of an hypertrophied condition. Thus, emotional excitement of a sexual kind, sexual excesses, over-stimulating food, irritant states of the urine, rectal constipation, sedentary habits, horse exercise, exposure to cold, especially of the lower extremities, may be regarded as accessory causes of this prostatic affection. But the *initial* cause or origin seems to be unknown.

Symptoms.—Commencing insidiously, chronic enlargement of the prostate progresses perhaps for months or even years, without interfering with the act of micturition so as to arrest attention. At length, some delay, rather than difficulty, in passing water is experienced; the stream is full, but less forcible than natural; it is concluded with an involuntary leaky dribbling, and sense of incomplete relief after apparently emptying the bladder. Micturition becomes increasingly frequent and urgent, a bearing-down weight is felt about the neck of the bladder and rectum, with pains in the glans penis and testicles, but which is not more acute after micturition. The urine voided appears healthy, although it be tinged with blood occasionally, or accompanied with some muco-purulent discharge. A man may have long suffered from some such symptoms; and if when examined, by introducing the finger up the rectum, the prostate be found enlarged and hardened, no doubt can then be entertained as to the nature of the case. This pathological condition supplies the true explanation of all the symptoms. The enlarged prostate projects upwards into the bladder, and urine accumulates in the reservoir thus formed behind the prostate. The bladder is never emptied below the level of the prostatic eminence. Consequently, frequent straining efforts are made; but the stream issues slowly, with less propulsive force, and ineffectually; the surplus urine only, or overflow, passes off, leaving the residual urine, often in large quantity, still remaining below the prostate in the bladder. Even this occasional relief can occur only when the bladder is sufficiently distended to obey its own contraction, and the straining compression of the abdominal muscles, to overcome the resistance offered by the enlarged prostate. An involuntary dribbling of urine may take place at intervals, from over-distension—the incontinence of adults. In some cases, owing to an open state of the vesico-

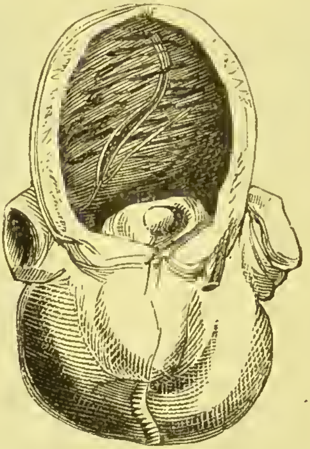


Fig. 37.—Roy. Coll. Surg. Mus., 2,481. Enlargement of the *right* lateral lobe of the prostate; showing *crescentic* urethral orifice, with its horns turned towards the right side. (Sir A. Cooper.)

urethral orifice, there is a constant dribbling of urine; an incontinence which may be distinguished from that of the occasional overflow, by emptying the bladder with a catheter from its inferior fundus; the dribbling will recur immediately through an open vesical orifice, but not until some time after, as overflow. Attacks of complete retention are liable to occur from any cause of temporary prostatic congestion; as by exposure to cold or damp, sexual excitement, or some error in diet; and such an attack is sometimes the first occasion of discovering the existence of prostatic enlargement. Under these circumstances some amount of hæmorrhage, and perhaps muco-purulent discharge, not unfrequently happen, for the relief of congestion. Ulceration of the prostate sometimes supervenes, attended with a sudden accession of suffering, beyond the ordinary symptoms of laboured micturition. For now, spasmodic contractions of the bladder, coupled with straining efforts, recur again and again—perhaps every ten, twenty minutes, or half an hour; throwing the patient into an agony, as the urine passes over the ulcerated portion of the prostate at the neck of the bladder, and to expel a small quantity, or a few drops only, of blood-stained fluid. Profuse bleeding may arise from transfixing a projecting portion of the prostate, in forcible catheterism.

The enlarged prostate as *felt* on passing the finger up the bowel, varies in size and consistence. Usually, it has the size of a large chestnut, or a small compressed orange, and of largest extent transversely—stretching perhaps across the bowel from side to side at the neck of the bladder; or either lateral lobe may be more enlarged.

The consistence of this body is firm and resisting, sometimes soft or unequally hard at different parts of the surface. It may be impossible to ascertain the extent of the enlargement backwards, which is often beyond the reach of the finger. When the middle lobe is also enlarged, this condition may escape detection by rectal exploration only; but when that portion of the prostate is principally or alone affected, it may be reached with the finger; and I have noticed that pressure upwards towards the vesical neck provokes the desire to micturate—an additional symptom of median central enlargement of the prostate. In anomalous cases, there may be a *nodular* enlargement, as of the right lobe and middle lobe; or a circumferential ridge may be formed around the vesical orifice. By tilting the base of the bladder upwards and forwards, some of the residual urine can be expelled; and by means of a catheter, several ounces of urine, to a pint or more, may be drawn off from the reservoir behind the prostate, although the act of micturition had just previously been performed.

In most cases, it is of no practical importance to carry the examination further. But *urethral* exploration with a catheter will supply information which rectal exploration cannot convey—respecting the elongation and curve of the prostatic urethra. By passing a full-sized catheter of the ordinary length and curve, we obtain a standard of comparison. If the urine flows when this instrument has traversed not more than the usual distance—about six to eight inches—while the handle has not been depressed more than usual, there will be no evidence of prostatic enlargement. But, if the catheter has passed easily nine or ten inches, and yet no urine flows—while, following its course, the handle has become depressed to a greater degree than usual—there will assuredly be some enlargement of the prostate; a judgment which may be confirmed by rectal exploration, so far as the lateral lobes are concerned. Then the *prostatic* catheter should be used; an instrument having a longer shaft by from two to four inches, and with a much larger curve (Fig. 38). The increased length and the altered direction of the prostate canal can be estimated by means of this instrument; the one fact, by observing the length of shaft introduced; the other, by its depressed position when the point enters the bladder. Any lateral deflection of the instrument, to the right or to the left, when allowed to take its own inclination, will further indicate a greater degree of prostatic enlargement on the side *towards* which the handle inclines.

The *mode* of passing a prostatic catheter is peculiar in two important particulars: the point of the instrument should be directed towards the upper floor of the urethra, and in turning under the pubic arch be hooked upwards, so as not to slope downwards in the perineum; the handle being depressed more than in passing an ordinary catheter. A small quantity of urine—perhaps an ounce, or more—may be drawn off from the pouch formed by the enlarged prostatic urethra; this flow taking place before, and as if, the instrument has entered the bladder, it is very apt to mislead the surgeon, who might therefore fail to complete the urethral exploration.

So far the prostate may be examined with the catheter, and by feeling with the finger in the rectum at the same time; thus ascertaining the thickness of the prostate, as well as the length and course of the prostatic urethra.

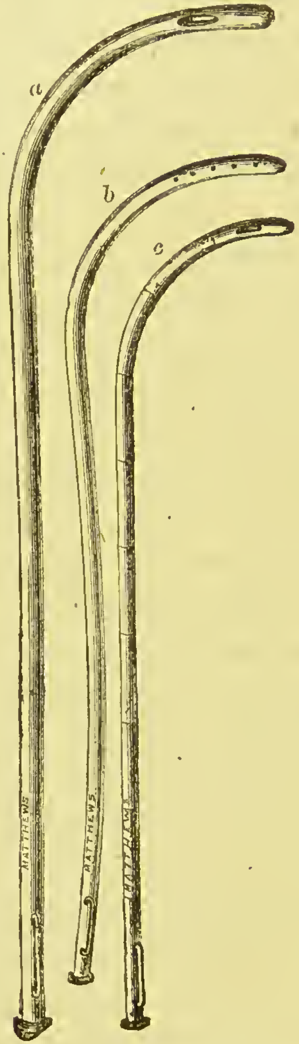


FIG. 38.—*a*. Prostatic catheter. *b*. Sir W. Fergusson's curve. *c*. Sir H. Thompson's curve.

If it should be thought necessary to explore the *vesical* portion of the prostate,—as to the enlargement of the middle lobe, with the fossa or receptacle behind it at the base of the bladder,—such examination can be made by means of a *sound* having a very short curve or only a beak. On passing this instrument into the bladder, the beak is turned down to sound the depth of the post-prostatic fossa,—possibly finding a stone there, which not unfrequently lies concealed behind an enlarged prostate; in withdrawing the beak forwards, the posterior limit of the prostatic enlargement can be defined, and the state of the middle lobe determined more clearly than by the up-curve in entering the bladder; and lastly, the crescentic shape of the vesical orifice may be indicated by gently turning the beak round to the right and to the left. Thompson's catheter-sound with fluted handle is also a most useful instrument for this exploration; having, moreover, the advantage, that as a catheter, the urine may be drawn off or the bladder injected, to suit the examination.

Having completed our examination of the prostate, so as to discover the enlarged dimensions of this body, the question of *diagnosis* can hardly be said to arise; but there are certain affections,—of the urethra and of the bladder,—from which enlargement of the prostate should be distinguished.

Stricture of the urethra may be distinguished, partly, by the act of micturition; the stream of urine is discharged with diminished force, but the volume is also diminished, even to the smallest stream short of retention, and it has a broken, twisted, or dribbling character. Catheterism, however, supplies the more accurate points of distinction; obstruction is encountered always before the point of the instrument reaches the prostatic urethra, and usually before six inches of the instrument have passed; whereas eight or nine inches of the instrument will have disappeared ere an enlarged prostate offers obstruction; and the handle must be depressed to a much greater degree than in passing stricture. The age of the patient also is different in the two cases; stricture always commencing before mid-life; enlargement of the prostate not until after that period.

Stone in the bladder is attended with somewhat similar symptoms to prostatic enlargement. But the vesical irritability and pain in the glans penis are more severe *after* micturition, for then the stone settles down on the sensitive base of the bladder behind the prostate; and both these symptoms are also then aggravated by walking, or any movement whereby the stone shifts its position. The stream of urine often stops suddenly, by the stone falling over the orifice of the urethra; but this symptom may also occur from an overlapping outgrowth of the middle lobe of the prostate, as a rare form of prostatic enlargement. Bloody urine is a more frequent symptom of stone in the bladder; and the hæmorrhage, which has a florid character, and is more copious, occurs especially *after* exercise, by attrition of the stone on the vesical mucous membrane. Sounding affords, however, the only conclusive evidence of stone. The diagnosis becomes far more doubtful in the case—not unfrequently met with—of an enlarged prostate *co-existing* with stone in the bladder, and masking its symptoms. If the calculus lies in the fossa behind the prostate when enlarged, the pain in the penis and vesical irritability will be mitigated or even absent; owing to the removal of the foreign body from the sensitive neck of the bladder. It is less apt to be washed over the vesico-urethral orifice, and thus obstruct the passage of urine; and any indication by the sudden cessation of the stream of urine is equivocal evidence, as arising perhaps from a polypoid outgrowth of the middle lobe. Then, however, occasional hæmorrhage or blood-stained urine may beget suspicion; and careful sounding may discover the stone in its bed, almost under cover of the prostate; and on passing the finger up the rectum, that body is more distinctly found to be enlarged. Thompson's catheter-sound is here most serviceable as a stone-searcher, in the post-prostatic receptacle of the inferior fundus of the bladder.

Any *tumour* of the bladder so far resembles an enlarged prostate, that both project into the cavity of this organ; but careful sounding with the beaked instrument will probably enable the Surgeon to define the different locality of the two outgrowths; and he may have his diagnosis confirmed by the distressing irritability of the bladder, the severe pain, the copious and recurring hæmorrhage; and at length perhaps he discovers some characteristic structural elements of the tumour, discharged in the urine, or such direct evidence is brought to light by inspection with the microscope.

Atony of the bladder differs from prostatic enlargement in the twofold fact, that, when a catheter is introduced, no urine or scarcely any flows by the propulsive action of the bladder,—the stream is simply a passive discharge; and that this current cannot be much accelerated by any efforts of the patient. Atony may, however, itself be due to the over-distension consequent on enlargement of the prostate. In *paralysis* of the bladder there is the same passive stream of urine when a catheter is passed; but there is also inability on the part of the patient to expel the urine by the action of the abdominal muscles,—this inability being proportionate to the completeness of the paralysis. Other parts, moreover, are involved, as the lower extremities; and this paralytic condition proceeds from injury or disease of the nervous centres—brain or spinal cord. The absence of any enlargement of the prostate should not be overlooked.

In concluding the history of this chronic affection, I have yet to notice its consequences, and modes of termination,—unhappily tending to a fatal issue.

Chronic cystitis commonly ensues from the habitual retention of urine, and distension of the bladder, which ultimately becomes atonied. An abundant secretion of viscid mucus or purulent matter, streaked with whitish phosphatic deposit, and sometimes tinged with blood, is voided in the urine; which is now alkaline, and of a pungent ammoniacal or fœtid odour. Occasionally, a deposit of urates and uric acid takes place, in connection with a gouty diathesis. Stone is very liable to form in the constantly retained residuum of urine, below the enlarged prostate. The urinary constituents are deposited probably around some inspissated mucus, as a nucleus; and the calculus is more often phosphatic, or perhaps an encrusting urate of ammonia. The quantity of urine passed varies much from day to day; being usually much above, although sometimes below, the average healthy standard. In consequence of the habitual retention, and inflammatory affection of the bladder, constitutional disturbance at length supervenes. The patient's general health declines, from broken rest, in frequent efforts to relieve the bladder, and from the exhaustion induced by chronic cystitis; he becomes sallow and dejected, he loses flesh and strength, and ages fast. Recurring attacks of complete retention throw him further back. Or, instead of this *gradual* decline, a *rapid* depression may occur from ulceration or sloughing of the bladder, with repeated hæmorrhage, or from profuse purulent discharge. *Uræmia*, from suppression of urine, sometimes closes the scene.

After death, certain pathological conditions of the urinary organs will be found to have resulted from the mechanical and backward effect of long-continued partial retention of urine. The *bladder* is dilated but thickened, principally in its muscular coat; the hypertrophied muscular bands project inwards in the form of prominent cords, between which the mucous membrane protrudes externally in pouched depressions,—under the constant pressure of the retained urine; thus the bladder has become fasciculated and sacculated. At the base or lower fundus of the bladder, a fossa or receptacle has formed behind the enlarged prostate, capable of containing perhaps several ounces of the ammoniacal, fœtid residual urine; and in which muco-purulent matter, and phosphatic deposit, are also apt to accumulate. The vesical mucous membrane has generally a greyish-slate colour. Backward pressure of the urine distends, and eventually dilates the *ureters;* and the secreting substance of the *kidneys*,—in their pyramidal and cortical portions, are atrophied; resulting perhaps in sacculated remnant kidneys. Hence, suppression of urine, and uræmia.

In the *treatment* of chronic enlargement of the prostate, palliative measures alone have any effect; this prostatic hypertrophy, naturally incident to advancing years, being incurable. The Surgeon must have in view, the relief of retention, by catheterism, or other operative interference when necessary; and the prevention or relief of chronic cystitis, and the maintenance of the general health.

Having regard to the constant *retention* of residual urine in the bladder, the organ should be emptied mechanically, at least once daily, or perhaps twice or three times; as occasion may require, owing to the amount of obstruction and varying degree of retention.

But what are the circumstances which should guide the practitioner as to the necessity for this interference, in the course of the progressive enlargement of the prostate? This question may be answered in different ways, according to the relative importance attached to the quantity, and the state, of the residual urine; and the disturbance of the general health, as by loss of rest, consequent on the frequency of desire to relieve the bladder. Practically, I conceive the significance of each and all these factors centres in their tendency to one issue. The probable supervention of *chronic cystitis*, and thence the marked difference in the patient's general health, from that time, is the condition to be apprehended. An atonic state of the bladder is prone to the occurrence of cystitis; but this state is to be measured by the quantity of residual urine, and its retention without inconvenience. The condition of the urine also will afford corroborative testimony of the same tendency—some cloudiness, not to say muco-purulent deposit, being quite sufficient indication of approaching cystitis, to suggest the necessity or advantage of using a catheter to prevent habitual retention.

Although these considerations apply to such interference in a comparative early stage of prostatic enlargement; in a more *advanced* stage, with constant retention of residual urine, to the amount of one or two pints, the bladder should be gradually accustomed to the relief of over-distension. The catheter must be used; but if the bladder be suddenly emptied, and repeatedly, at intervals, two or three times daily, this method would have the effect of shock to the system—something like the impression produced by the collapse of a psoas, or other large abscess, when suddenly emptied. The patient is, indeed, relieved of his tormenting bladder-difficulties, but he becomes weak, and loses his little appetite, while pre-existing kidney-disease is brought into activity, and he dies in a few weeks, exhausted or uræmic. Sir B. Brodie first drew attention to the important precautions to be taken in dealing with this ultra-chronic state of bladder-retention. He first inculcated the practice of a temporary compromise between leaving such cases to their inevitable fate, and suddenly changing the long-accustomed distension of the bladder, at the risk of hastening the patient's death. Let then a portion only of the urine be drawn off, and several days elapse before the bladder is completely emptied once. Even the change from a natural, albeit ineffectual, mode of micturition, to an artificial one, may induce cystitis; and, therefore, during this transition, the use of the instrument must be gradually proceeded with—once a day, then twice, and so on—until it can be safely borne, as occasion may require. While thus attending to the bladder, the general health should be supported by the usual resources of diet and tonics.

The *prostatic* catheter is larger-sized, longer and more curved than an ordinary catheter; and thus being adapted to the corresponding alterations in the urethral canal, the urine can be more conveniently drawn off by this instrument. The three points—previously mentioned—should be here remembered, in passing this instrument into the bladder: not to mistake the dilatation of the prostatic urethra for the bladder, an ounce of urine or more perhaps thence escaping as if the catheter had entered its cavity; the up-sweeping of the point of the instrument under the pubic arch, with depression of the handle sufficiently between the thighs; so as to curve upwards into the bladder, and thus also avoid hitching against any enlargement of the middle lobe. Care should be taken to empty the receptacle behind the prostate, by turning down the point of the catheter, before withdrawing it. The patient should be taught to pass the instrument in his own person, that he may be enabled to relieve himself. A gum-elastic catheter, of large size, will then be more convenient and safer than the silver instrument; the patient passing it bit by bit. When the point has reached the prostatic urethra, the stylet should be withdrawn, that the curve of the catheter may glide upwards into the bladder. Mercier's *sonde coudée*, a beaked elastic catheter, will prove serviceable when the middle lobe is enlarged; or the *sonde bicoudée*, having a second beak, is thus adapted to mount up more readily into the bladder (Fig. 39). With enlargement of either lateral lobe, in addition to median-enlargement, the curving of the prostatic urethra to the right or to the left, may be followed, more easily, by introducing an india-rubber tube, which is sufficiently pliable and resistant to find its way, without having any fixed curve. Or the lobster-jointed metallic instrument—devised by Squire, of Elmira—may be used in such cases; and especially when, owing to a nodulated and irregular enlargement of the prostate, an instrument of varying resistance will be more suitable for the passage. As a rule, it will be unnecessary and undesirable to leave the catheter in the bladder; but if requisite to procure ease and sleep, this may be allowed, as during the night. The gum-elastic, or vulcanized india-rubber catheter, is then preferable, as being less irritant to the mucous

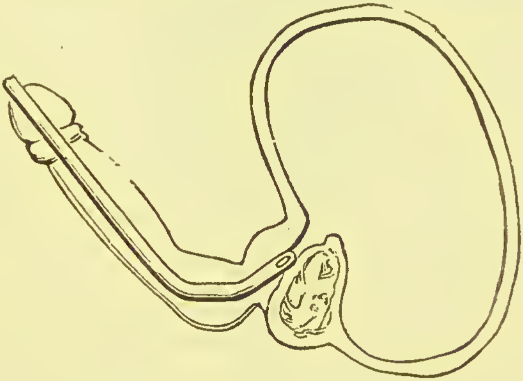


FIG. 39.

membrane. Various self-holding instruments have been made, but without offering any positive advantage. The catheter should not be used more frequently than night and morning, or thrice in the twenty-four hours. The more frequent catheterism, say every two hours, which may become necessary in exceptional cases, must be left to the judgment of the Surgeon. By thus habitually relieving the retention of urine, the patient's existence becomes more tolerable or even comfortable, and his life may be considerably prolonged. The bladder may be washed out occasionally by an injection of tepid water, to remove any muco-purulent matter and gravel, or to prevent the formation of stone from any residual decomposing urine. The patient should be taught to do this also for himself, besides that of passing the catheter.

But supposing no instrument can be got into the bladder, other methods of gaining an entry may be resorted to. They are, forcible catheterism or tunnelling the prostate, puncture of the bladder through the rectum, or puncture above the pubes. Of these three methods, forcible catheterism is sanctioned by Brodie, Liston, Spence, and other Surgeons of large experience, as a safer procedure than puncture per rectum, or suprapubic. The instrument having been thrust through the obstructing portion of the prostate (Fig. 40), is left in the bladder for about forty-eight hours, to establish a false passage for its re-introduction. But I have known severe prostatitis to be thus induced, and more complete obstruction; or copious hæmorrhage has been caused, more blood passing back into the bladder than escapes through the urethra; and in one case, I am sure the patient bled to death. I decidedly prefer having recourse to puncture of the bladder through the rectum; but this, and the other procedure, above the pubes, will be considered and described in the treatment of stricture of the urethra. Either of these methods of entering the bladder may become necessary, for the *permanent* relief of retention, in advanced age, when the patient cannot relieve himself with the catheter.

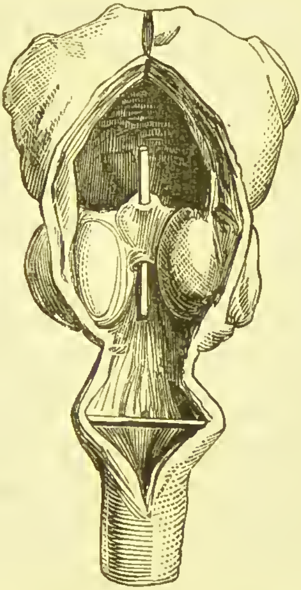


Fig. 40.—Roy. Coll. Surg. Mus., 2,509. Effects of forcible catheterism, showing tunnelling of the enlarged *middle* lobe of a prostate. The prostatic and membranous portions of the urethra were acutely inflamed, and near the glans penis abscess had probably occurred. The patient, an old man, had often previously been relieved of retention by means of a catheter; but a Surgeon, having found some difficulty in entering the bladder, perforated the prostate with the instrument; and death ensued in two or three weeks. (J. G. Crosse.)

The tendency to chronic cystitis from prostatic enlargement is partly averted by preventing retention; at the same time, the diet should be carefully regulated, and exposure to cold or damp avoided; in short, any cause of any disordered state of the urine, or of determination of blood to the bladder. The remedial treatment of this vesical affection has already sufficiently engaged our attention. Nor need more be said respecting the support of the general health.

In the event of symptoms denoting ulceration of the prostate, our efforts will be directed to allay pain, by opiates internally and per anum; passing a catheter, not only to prevent any collection of urine in the intolerant bladder, but to relieve the patient from the constantly recurring suffering of passing urine over the exposed surface of the prostate.

Atrophy of the Prostate sometimes occurs in old age; or it may be found in early adult life, then probably being an imperfect development of this gland, or connected with malformation. The organ may waste in the course of general emaciation, from such diseases as phthisis; or from some local cause affecting its nutrition, as by the ingrowth of a tumour, or calculus. Double castration, or the division of both seminal ducts in bilateral lithotomy, tends also to atrophy of the prostate. No special symptoms are known, nor does this condition admit of any remedial treatment

CANCER OF THE PROSTATE.—Occurring less frequently as a secondary deposit, than as a primary disease, prostatic cancer is almost always encephaloid, and sometimes combined with melanotic matter; scirrhus is rarely if ever met with.

The prostate undergoes enlargement, and the symptoms are those of the simple chronic enlargement or hypertrophy. But the patient complains of severe pain, shooting into the rectum, up the sacrum, and down the thighs; he is alarmed by repeated and profuse hæmorrhage in passing water; and his bloodless, spectral appearance tells the story of suffering and exhaustion. On passing the finger up the bowel, a tumour is at once felt, which—as compared with an ordinarily enlarged prostate—is of larger size, harder, and perhaps irregular; or, at a later stage, it feels softer and fungating. The lymphatic glands in the groin are found to be affected, and, by careful palpation, some enlargement of the lumbar glands may be detected. This concurrence of symptoms will probably suffice to indicate the nature of the prostatic disease,—or at least the difference from ordinary glandular hypertrophy. Hæmorrhage from the urethra often occurs, or bloody urine, and which has been said to exhibit, under the microscope, cancer-cells; the resemblance, however, of the epithelial cells, would render this evidence doubtful. But the Surgeon will further take into account, the rapidity with which the symptoms have made their appearance; the disease running its course from first to last, in a period not longer than from a year and a half to five years in adults, and from three to nine months only in children; and that this malignant prostatic enlargement is not at all peculiar to advancing age. Sometimes, the coexistence of cancer in the testicle begets suspicion in even an early stage of prostatic cancer, which may be a secondary affection to the disease in that organ, or in the kidney.

Palliative *treatment* may relieve the distressing symptoms of this disease. The partial retention would seem to warrant the use of an elastic catheter; but instrumental interference should be avoided as long as possible, and then catheterism should be performed with the gentlest manipulation, not to irritate or injure the painful and bleeding prostate. Supra-pubic cystotomy would here seem to be advisable, not only for the relief of retention, but to establish a permanent diversion of the urine from the diseased prostate. The suffering would thus be relieved, and life prolonged. I am not aware that this procedure has been practised. Anodynes, in the form of opium or conium more particularly, may be administered both by the mouth and rectum. If, besides thus allaying the severe pain, as the disease progresses, sleep can be procured, the patient may well feel thankful for that double boon. Attacks of hæmorrhage must be treated as explained in connection with hæmaturia. But the bleeding of a bleeding-growth, such as encephaloid cancer, is even less controllable than its painful character. The consequent exhaustion will require all the support which can be given by tonics, and a nourishing diet. Iron and quinine, in their various preparations, are the most efficacious; while the choice of food should be regulated as the digestion responds to the various resources of experience. The general health and strength may thus be sustained, and life prolonged.

A *cystic* condition of the prostate may be mentioned more in relation to its pathological interest, than as having much practical importance with regard to its diagnosis and treatment. In old age especially, the substance of the prostate is often beset with numerous cavities, of an irregular shape, apparently dilated prostatic follicles, and communicating with the ducts of the gland. Minute concretions or prostatic calculi of larger size are apt to form in these cysts. Then again, the whole substance of the gland may have become converted into a cyst or abscess, resulting from long-continued suppuration. Occasionally, an *hydatid* cyst forms between the base of the bladder and the rectum. This extra-cystic condition is attended with retention of urine, and distension of the bladder; simulating the symptoms of an enlarged prostate.

Tubercular deposit very rarely affects the prostate, and always secondary to some other part of the genito-urinary tract as the primary seat of deposit. The kidney is affected first, the testicle, or epididymis. Generally, the prostatic disease is associated with phthisis pulmonalis. Prostatic tuberculosis is met with usually between the ages of twenty-five and fifty-five. The symptoms are in no way peculiar or well-marked. A phthisical-looking man, or scrofulous child, is troubled with frequent and painful micturition, as if a case of vesical irritability from any other cause; there is some obstruction to the free passage of urine, and slight hæmorrhage recurs at intervals. But these symptoms might indicate chronic prostatitis. Rectal examination discovers some amount of prostatitic enlargement, and perhaps irregularity of the organ. The vasa deferentia and seminal vesicles are also sometimes felt to be enlarged, knotty, and indurated by the deposit, when these parts being involved, the finger can be passed beyond the enlarged prostate. Subsequently, however, with suppuration and discharge, the prostate becomes smaller than natural, and the urine purulent; but the tubercular abscess is obstinately indisposed to close up. Otherwise, the absence of any special symptoms, and the co-existence of at least a phthisical tendency, will indicate the nature of this disease. The suspicion originally entertained, is confirmed by the slow progress of this prostatic affection.

Commonly terminating in death from exhaustion, or from pulmonary phthisis, the patient may at length recover under favourable hygienic circumstances.

Treatment must be conducted on general principles, in reference to the constitutional diathesis.

PROSTATIC CALCULUS.—The prostate gland, like other glands, is liable to an inspissation of its secretion, forming a nucleus, around which phosphatic concretion takes place, in concentric layers, within the ducts of the follicular structure. This mode of origin, and situation, distinguish true prostatic calculus from urinary calculus which may have only lodged in the prostate. The physical characters of these calculi are such as may be easily recognised. Their colour is commonly a brownish-yellow or orange, sometimes black, red, or white; rarely transparent or like pearl-barley; of softish or hard consistence; but their form is very irregular, faceted, triangular or square; and their size varies from that of granular sand to a poppy-seed or cherry-stone. Section of the larger-sized shows a concentric structure, and sometimes a radiated appearance. In point of number, 1, 2, 3, or more, even to 100, may have formed, like a bag of marbles. By constant attrition, the facets become smoothed and polished. Continued deposition of phosphatic matter at length produces a larger calculus; which encroaches on the rectum, or comes forward out of the mouths of the distended prostatic pouches into the prostatic urethra; thence extending forwards, or backwards into the bladder, it forms a prostato-vesical calculus. Sometimes, one or more prostatic calculi become detached, free and movable in an open duct. These enlarged calculi have a very irregular or branched appearance. A remarkable prostatic calculus was presented by Dr. H. Barker to the Museum of the Royal College of Surgeons. It has a pyriform shape; measures in length nearly five inches, in circumference, at its thickest part, four inches and five-eighths; and weighs three ounces and a half. The stone consists of twenty-nine pieces, the facets of which are regularly fitted together; indicating that its formation took place in the crypts of the prostate, separately, and that the pieces coalesced by subsequent absorption of the glandular substance; thus resulting in this multiple calculus.

By these characters, prostatic calculus may be distinguished from a vesical calculus when lodged in the prostatic sinus; and it differs also from the inspissated calcareous matter of a chronic abscess, and from phleboliths, which form within varicose prostatic veins.

The *symptoms* to which prostatic calculi give rise, depend principally on their size. When small, there may be no symptoms, or such slight inconvenience as not to attract attention. When of larger size, they are attended with pain and weight in the perineum, and uneasiness at the neck of the bladder; there is frequent micturition, sometimes retention, and difficulty in the emission of semen, although attacks of priapism may have misled the sufferer to more frequent sexual intercourse. All these symptoms point to an enlarged and irritated prostate; and, by urethral or rectal exploration, one or more stones can be touched with an instrument, or felt, through the prostate with the finger (Fig. 41). On passing a sound through the urethra, a distinct click or grating is heard and felt, just before the beak of the instrument enters the bladder; a deeply imbedded calculus may be felt, on passing the finger up the rectum; or by simultaneous examination with the finger and sound. A large number of small stones communicate to the finger a crackling or grating sensation, like that of small marbles in a bag. Commencing with microscopic size after puberty, these prostatic concretions are found in patients of middle age or advanced life.

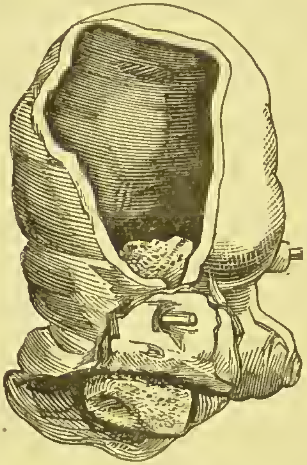


FIG. 41.—Roy. Coll. Surg. Mus., 2,039. Prostatic (?) calculus, of large size, remaining in the prostatic urethra and neck of the bladder, after lithotomy. The patient, aged fifty, lived for two years after the operation, with all the symptoms of stone, and the wound remaining open. (Liston.)

As the result of prolonged irritation, suppuration may ensue, forming prostatic abscesses, and perhaps leading to the discharge of concretion, through fistulous communications—perineal, rectal, urethral or vesical. Or, from the retention of urine, chronic cystitis results, and the other backward consequences of prolonged urethral obstruction.

Having found a calculus in the prostate, what *treatment* should be adopted? When there are no urgent symptoms, the case may be wisely left alone, so far as regards any attempt to remove the stone by operative interference. Symptoms of irritation can perhaps be subdued by opiate suppositories, and careful regulation of the bowels to prevent any rectal constipation; while retention of urine is relieved by using the catheter as occasion requires. If the calculi are small and movable, they may admit of extraction through the urethra, by means of a long urethral forceps. But this mode of operation is not easily accomplished. When the stones are large, and not more than two or three in number, median lithotomy, or perhaps the recto-vesical operation, should be performed, and extraction effected with scoop or forceps. A larger-sized calculus had better be removed by the lateral operation. In either procedure it will be necessary to completely remove the whole formation, by washing out the prostate and bladder; any bit remaining would be the nucleus of fresh concretion.

Sometimes the Surgeon has to deal with a urinary calculus or fragment, lodged in the prostatic urethra; here the urethral forceps can more often be employed with advantage; or failing thus to remove the stone, it may be pushed back into the bladder, and submitted to lithotrity or lithotomy.

Lastly, the occasional co-existence of prostatic and vesical calculus present a difficulty in the way of the lateral operation. Yet, under these circumstances, this mode of removing both calculi may alone be practicable.

Renal Calculus.—The *symptoms* of stone in the kidney have been already noticed; but the *treatment* of this condition when persistent merges in that of other conditions, which result in irreparable destruction of this organ.

Nephrectomy, and Nephro-lithotomy.—Various incurable *diseases* of the kidney are liable to occur; in the form of cancer-growth or other tumour, or as pyelitis, with complete destruction of the renal structure, in which extirpation of the organ has been practised occasionally of late years, as the only resource—this operation being named *nephrectomy*.

In other cases, even more often, without excision of the kidney, a *calculus* has been removed by incision of the organ—the operation of *nephrotomy*, or *nephro-lithotomy*, when performed for this purpose.

Nephrectomy. — Considerable difficulties have beset the extension of Surgery in favour of this operation. The obvious difficulty of *diagnosis* is experienced on the very threshold of operative interference. This has been surmounted only, in some cases, by exploratory incision down to the kidney, resulting, perhaps, in an incompleted operation. So far, nephrectomy might have to be performed under somewhat similar circumstances as ovariotomy, if not with regard to the nature of the tumour, yet as to the surgical propriety of completing the operation. But, in connection with the question of extirpating the kidney—an organ having such intimate functional relations to the constitution of the blood, and thence to the functions of other organs, the *physiological* effects and consequences of nephrectomy would also have to be investigated and taken into account.

Professor Simon, of Heidelberg, who first successfully performed the operation, took up the inquiry from this point of view. The fact that one kidney may gradually become useless, as the consequence of slow disease, without any appreciable effect upon the general health, was supplemented by experimental observation of nephrectomy in animals, with the result of showing that neither uræmia nor albuminuria ensued from the sudden cessation of the function of one kidney. The remaining organ rapidly increased in size, as an hypertrophic compensation for the double functional work imposed upon it.

The immediate surgical *risks* of the operation—with regard to shock, and hæmorrhage, and peritonitis—have proved to be not greater than are incidental to other surgical procedures of equal consequence.

These encouraging data—physiological and surgical—have since been fully confirmed by the progressive experience of nephrectomy in the human subject: as by Martin, of Berlin (1878); Smith, of New Orleans; and other Surgeons in Germany, America, and in this country. The promising success of this operation rests on the assumption that the remaining kidney is healthy.

Operation.—Nephrectomy may be performed either by

Abdominal Section (gastrotomy), or Lumbar Incision. The ventral operation may be performed, either in the middle line, or just outside the margin of the rectus abdominis muscle, as recommended by Langenbeck.

(1) *Abdominal Section.*—The *median* section is made, as in ovariotomy, from below the umbilicus, downwards to the extent of three or four inches, towards the pubes. Langenbeck's somewhat *lateral* incision is placed higher up, and corresponding nearly to the outer margin of the rectus; so that this line lies more directly over the kidney, and the abdominal section is comparatively bloodless, perhaps also allowing the peritoneum to be reflected without opening the cavity, in removing the organ. To these advantages may be added the consideration that it might become necessary to prolong the median incision to above the umbilicus, in order to fairly reach the kidney.

The patient being under the influence of bichloride of methylene—which is less likely to provoke sickness than any other anæsthetic—in either line of incision the abdominal parietes are carefully divided by successive strokes with the knife; the peritoneum is then opened and slit up on a broad director or finger, care having been taken not to mistake the fascia transversalis for the peritoneum, which, on passing the hand into the abdomen, would be detached from the wall without entering the cavity. In dividing the abdominal parietes, any bleeding points should be secured by small clamp forceps, before opening the peritoneum. On passing the hand into the abdomen, the kidney is readily found behind the intestines, which are retained from protruding by a large flat piece of sponge overlaying them on the other side. The renal layer of peritoneum is now to be torn through, and the finger passed around the kidney, slowly, and cautiously detaching it from its bed, so as not to lacerate the renal substance. Having completely isolated the organ, it is brought out of the abdomen; the ureter is divided between a double ligature of Chinese silk—containing no cotton; the vessels and fascia, forming a pedicle, should be ligatured by transfixion with a curved aneurism needle, armed with the silk, and passed through the pedicle *between* the vessels; each half is then to be secured by interlocking the ligatures (as in the ovarian pedicle), and tying them on either side, finally embracing the whole pedicle as an additional security. On dividing the pedicle, beyond the ligatures, the vessels should be seen not to bleed; and the cut end is then dropped into the abdomen—as in the intra-peritoneal ovariotomy, now generally performed. But Mr. Knowsley Thornton lays great stress on *not* thus dealing with the *ureter*. As an additional aseptic precaution of the most vital consequence—beyond performing the whole operation antiseptically—he retains the bladder-end of the ureter outside the abdominal incision, in order not to leave the septic material this tube must contain, within the peritoneum. The end is firmly tied with strong silk, and then cut off beyond; leaving only just sufficient stump to transfix with a pin, and thus prevent it from slipping back into the wound. This ureter-stump is well cleaned with iodine, and packed around with a little cotton squeezed out of the tincture.

The abdominal cavity—previously—should be carefully sponged dry, observing to dip down into the peritoneal pouch in the pelvis. Waiting until any oozing hæmorrhage has ceased, or been completely stopped by sponging with iodine-tincture; then, and not until then, the incision is to be accurately closed by interrupted sutures of fine silver wire, placed about half an inch apart, and entered near the margin of the incision; each suture transfixing the whole thickness of the abdominal wall, including the peritoneum, on either side; the ends should be twisted so as not to leave any cutting strain on the wires. A pad of dry lint, placed over the line of incision, and retained by a few turns of a broad flannel bandage, is the only dressing required. If the operation has been conducted under the auspices of carbolic spray, gauze-dressing will be used.

(2) *Lumbar* nephrectomy resembles the operation of colotomy as performed in the loin. An oblique incision is made between the last rib and the crest of the ilium, to about four or six inches in length; commencing external to the outer margin of the erector spinæ muscle, and falling below on the middle third of the iliac crest. Having successively divided the muscular layer of the abdominal wall, and perhaps cut the external border of the quadratus muscle, the fat around the kidney is displaced with the finger, and the organ turned out, without wounding the peritoneum. The ureter is to be ligatured, and the pedicle of vessels secured, as in the abdominal operation.

Either operation for extirpating the kidney may be found much more difficult than it would appear to be simply as an anatomical procedure, owing to the various pathological conditions of the kidney for which nephrectomy is undertaken in different cases. In lumbar nephrectomy, it has been found necessary to divide or excise the last rib, in order to obtain space for extirpation of the mass or tying the pedicle. This complication, however, did not interfere with the success of this operation, in two cases, as thus performed by Czerney; but the pleura has been accidentally opened, in such cases, with fatal collapse of the lung. This misadventure would arise probably from mistaking the eleventh for the twelfth rib, when the latter is rudimentary; although the pleura is not necessarily implicated in section of the last rib.

The *comparative* merits of ventral and lumbar nephrectomy cannot be fairly estimated at present; each operation being appropriate for removal of the kidney in different diseases of this organ; and which may not be known until discovered during operation. The ventral operation certainly has the advantages of providing for the complete removal of any mass that should be submitted to such surgical interference; and the sound or unsound state of the other kidney can also be then ascertained, with a view of determining the probable issue.

In considering the *results* of nephrectomy, not much can be added to what may be gathered from the collection of 54 cases, in a valuable paper* by Mr. A. E. Barker. It appears that, up to that date, the kidney had been removed by abdominal section, 27 times, with 17 deaths; and by lumbar incision, also 27 times, with only 11 deaths.

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* "Med. Chir. Trans.," vol. lxiv.

But the former series includes 11 cases wherein ventral nephrectomy was not the original object of the operation; and in the remaining 16, there was an equal proportion of 8 deaths and 8 recoveries. Thus, while the ventral operation shows recoveries to 50 per cent., the lumbar operation may be credited with the still higher proportionate success of about 59 or 60 per cent.

A singularly instructive case occurred in the practice of Mr. Knowsley Thornton: nephrectomy, by abdominal section, having been preceded by lumbar nephrotomy, and a good recovery resulting from either operation. I am indebted to Mr. Thornton for the history of this case, which well illustrates the circumstances under which either operation may be practised; and also the difficulties or the details experienced in the course of these proceedings. I had the opportunity of being present at the operation of nephrectomy.

M. D., aged twenty-six, married two years ago, within which period she had borne two children, and had one previous miscarriage. During the last pregnancy she experienced pain in the right loin, and the urine became thick, with a "shiny" deposit. Prolonged parturition was followed by severe flooding; on the eleventh day, inflammation in the right iliac fossa supervened, and a week later, the left leg was painful and much swollen. The renal pain having continued, it assumed a spasmodic character, shooting down the course of the ureter towards the right thigh. Some swelling in the loin had enlarged into a tumour of considerable size, with the colon curving round its inner border. The urine was now loaded with pus, and ammoniacal, accompanied with the constitutional symptoms of hectic fever. In this state she was admitted into the Samaritan Hospital, February, 1882. It being doubtful whether the case was one of "scrofulous pyonephrosis" or calculous pyelitis, an exploratory operation was performed, by an incision in the loin, down to the kidney,—full Listerian precautions of antisepticism having been adopted. The chief practical points noticeable in this procedure were the free hæmorrhage, both from the tissues and the kidney, when cut into; and the very imperfect knowledge to be gained as to the condition of the organ. No stone could be found, only a sacculated kidney, containing very offensive pus. Two large drainage-tubes, therefore, were introduced, and the remainder of the wound was closed by sutures, two of which were passed through the upper and lower angle of the incision in the kidney, and gauze-dressing applied. After operation the temperature rose in a few hours to 104·6°, and the pulse, which was very feeble, to 108; the first urine from the bladder was loaded with pus, the second still contained some, but the third was clear and normal. The operation had demonstrated the healthy condition of the other kidney. Symptoms of carbolism, however, soon appeared; and although the antiseptic gauze-dressings were reduced in size to the narrowest limits consistent with any chance of asepticity, the olive-green colour of the urine was still marked. The dressing was then exchanged for eucalyptus-gauze, and the state of the urine improved; but putrescence continued, and "pus which had soaked through sixteen layers of the gauze, teemed with all kinds of bacteria." The wound healed fairly well, the sutures were removed, and first one tube and then the other were withdrawn; and, for a time, the patient's general condition greatly improved. But the evening temperature remained about 100·0°; and in three weeks, pain in the course of the ureter, which had never entirely ceased, increased again; while the general health declined. Under these circumstances nephrectomy was resorted to, and with good hope of success, as the other kidney had been proved to be healthy. March 11, 1882, abdominal section was performed, by Langenbeck's incision, along the outer border of the rectus abdominis, under Listerian precautions. The remnant loin-opening served the purpose of affording free drainage to septic matter, both during and after the abdominal operation. In order to destroy existing sepsis, a catheter was first passed through the loin sinus into the kidney, which was then flooded out with iodine water. A longitudinal incision to the extent of six inches in the above-mentioned line, gave less hæmorrhage than the usual median incision. The peritoneum was opened, and the kidney at once exposed, without seeing omentum or intestine. A hole was scratched through the peritoneal layer over the kidney, and the organ enucleated down to the vessels at the hilus, with but slight bleeding. The vessels were secured separately, and then a third ligature was passed around the whole pedicle; this being done nearly an inch from the aorta, and leaving sufficient distal stump after division of the pedicle. The remainder of the organ was enucleated with difficulty, especially around the loin-opening, so that a portion of the capsule was left. Several vessels in the fat and capsule were tied with fine carbolized silk, and the ends cut short. The kidney having been drawn out, the ureter was seized in two places, near the organ, with strong Wells's forceps, the tube divided between them; and immediately closing the bladder-end with iodized sponge, it was tied and held outside the wound. A sponge soaked with iodine-tincture was then passed down, and out through the loin-opening; this failing to arrest the oozing of blood among the lumbar muscles, perchloride of iron was applied in like manner. To maintain free drainage, a red rubber-tube was passed from the lower angle of the abdominal incision, through and out at the loin. The incision was closed up to the tube with carbolized silk sutures; and the end of the ureter brought outside the wound, and fastened by a pin. This expedient to prevent septic infection from the bladder, is peculiar to this operation as performed by Mr. Thornton.

The kidney, after removal, weighed 1 lb. 2½ oz., was largely sacculated, and contained a number of small, dark calculi, apparently oxalate of lime.

The patient made a good recovery, there being a marked difference of temperature in favour of the case, as compared with that after the previous loin-operation of nephrotomy; but some green colouring of the urine after the abdominal nephrectomy, indicated carbolic-poisoning. Both wounds—in the abdomen, and in the loin for drainage, healed completely on the same day, the 18th; and the patient returned home well on the 30th day—a month well spent.

CHAPTER V.

DISEASES OF THE URETHRA.

No branch of Surgery possesses a more abundant literature than Urethral Diseases; and no subject, in my judgment, has been more overwritten. These diseases have been incidentally alluded to, as associated with vesical and prostatic affections, and may be thus enumerated: (1) Inflammation of the Urethra, or Urethritis, and its more specific form, Gonorrhœa; (2) Stricture or contraction of the canal, in some part or parts of its extent,—as a structural or organic and permanent condition, or as a spasmodic, or an inflammatory state; (3) Tumours occasionally; (4) Urethral Calculus. The results of Urethral obstruction comprise: Retention of Urine; Extravasation; Rupture of the Bladder; and Urinary Fistulæ — penile, scrotal, perineal, urethro-vaginal, and vesico-vaginal fistulæ.

Urethritis.—*Simple* inflammation of the urethral mucous membrane may arise from various causes, at any age, and in either sex. Anyone, who may be thus affected, experiences heat, pricking, and tension in the urethra, for a day or two, with some smarting or perhaps scalding sensation in passing water; symptoms which are followed by a muco-purulent discharge. Sometimes, the only symptom is this whitish discharge from the urethra, unaccompanied with any inflammatory character.

The *diagnosis* of this urethral affection, in either form, is very important, from its resemblance to gonorrhœa. In the *active* condition of simple urethritis, the distinction from gonorrhœa is extremely difficult; in the *passive* condition, it resembles gleet, but differs in the thicker and more opaque character of the urethral discharge. The causes of simple inflammation of the urethra differ also from that of gonorrhœa which arises from a specific contagion; though here, it must be confessed, the line of distinction is even less definite.

Certain constitutional diseases, gout, rheumatism, scrofula, and the influence of particular medicines, as cantharides, guaiacum, or Cayenne pepper, frequently induce urethritis. Some such causes seem to affect the urethra through morbid states of the urine, as when it is loaded with lithic or with oxalic acid; thus producing *direct* irritation in the passage of such urine. They give rise to the active form of urethritis, and the discharge usually disappears immediately upon the development of the constitutional disease. Scrofulous urethritis is, however, apparently a local manifestation of the general disease, just as there may be a discharge from the nasal mucous membrane. *Distant* irritation, as gastric derangement, worms in the intestines, or teething, may also excite an urethral discharge; but this is of a passive character. Local causes of various kinds are not unfrequently the occasions of urethral irritation; as the passage of instruments, a fragment of stone or other foreign body in the urethra, injections, sexual intercourse or excitement, the introduction of vaginal discharges,—such as the menstrual fluid, or leucorrhœal matter. Here again, the discharge is usually passive. Urethral tubercular deposit may also be attended with discharge, of which Ricord gives an instance. The development, or recurrence, of secondary or tertiary syphilitic eruptions, has been followed by a muco-purulent flow from the urethra—according to the observations of Bassereau, Bumstead, and Van Buren.

All these causes should be taken into consideration before pronouncing a professional judgment as to the particular cause in any case of urethritis. Thus, in a young child, the existence of vaginal and urethral discharge is not absolute evidence that a rape has been committed; and in persons who are subjects of stricture and irritable urethra, a discharge apparently gonorrhœal sometimes exists, or appears after sexual intercourse or excitement, a debauch, or other cause of urethral irritation.

Simple urethritis generally subsides in a week or ten days, unlike gonorrhœa, which continues some weeks or even months. But the discharge often becomes chronic in gouty persons, or when associated with stricture.

Treatment consists in removing any cause of urethral irritation, and allaying the inflammatory symptoms. Thus, in a gouty or rheumatic case, both these indications may be answered by the administration of alkaline saline aperients, combined perhaps with colchicum;

aided by a moderate and non-stimulating diet. When the discharge has become passive, weak astringent injections, as of the diacetate of lead, alum, or sulphate of zinc, will gradually arrest the urethral secretion and complete the cure. I never use the two latter forms of astringents, nor find it necessary to have recourse to copaiba or cubebs.

As associated with stricture, urethritis may occasion a temporary retention of urine, partly spasmodic. Then, in addition to what is termed antiphlogistic treatment, the relaxing influence of opium, or opiate suppositories, and a warm hip-bath, will usually overcome the obstruction. The use of a catheter should be postponed until relief cannot be otherwise obtained.

Gonorrhœa or *Blennorrhagia.*—This form of urethritis is attended with muco-purulent discharge, of a *specific* character; and is generally produced by contagion or contact with a *similar* discharge, usually during sexual intercourse. It may affect, and infect, either the male or female.

In the *male*, the urethra is the seat of gonorrhœa, and particularly the anterior portion of the mucous membrane,—as far as the fossa navicularis within the glans penis; but the urethral inflammation sometimes extends backwards along the whole length of the passage, and may even involve the mucous membrane of the bladder, in extreme cases. When gonorrhœal inflammation subsides into a chronic state, the bulbous portion of the urethra is more especially affected, the intermediate anterior portion up to the glans being comparatively free. Other portions of the genital mucous membrane are often *secondarily* involved, as that of the prepuce and glans.

The symptoms of gonorrhœa differ in the course of the disease, and which may thus be divided into four tolerably definite stages. Commencing generally from the second to the fifth day after contagion; a short period of urethral irritation is followed by acute inflammation, which subsides into a declining or chronic stage; terminating perhaps in gleet, a chronic state of peculiar discharge which does not always supervene.

Urethral irritation is attended with very slight symptoms; an itching or tickling sensation in the meatus; its lips have a florid red, and puffed appearance, and are glued together by a scanty, viscid, clear and colourless or slightly opalescent secretion. In passing water, some smarting is experienced, but no scalding—no ardor urinæ. This stage lasts from a few hours to two or three days.

Acute inflammation gives rise to the discharge of a purulent secretion, having a thick, creamy consistence, an opaque and greenish-yellow colour: it can be pressed out of the urethra in sulphur-looking drops, and is usually so abundant as to stiffen the shirt in patches; an acute scalding pain is felt in passing urine, which is voided with some difficulty in a diminished or forked stream, or in spasmodic jerks, and with increased frequency; although the patient refrains from micturition as long as he can contain, regarding this procedure as quite a little operation. The glans penis is turgid and of a bright cherry-red colour, the urethral canal is swollen and cord-like to the touch; the prepuce may become œdematous, and at length the whole penis looks and feels turgescent. Should the inflammation pass back to the bulbous urethra, a sensation of weight in the perineum will be experienced; and reaching the prostatic urethra, a bearing-down weight about the anus is superadded. The heavy and enlarged penis seldom remains pendent and quiescent for many hours by day or night; under any rubbing irritation of the dress, or from warmth in bed, erections often occur with troublesome inconvenience; or *chordee* not unfrequently arises, in the form of a painful arching or twisting of the penis downwards during erection, a penalty inflicted in oft-repeated attacks. This bent position of the organ in erection, seems to be the result of lymph-effusion around the urethral canal, producing an inextensible state of the corpus spongiosum at the part affected. Whenever, therefore, an erection would take place, as the cavernous body of the penis becomes distended, the unyielding spongy urethra acts like the string of a bow, and bends the penis downwards. Another explanation is, that chordee arises from spasm of the muscular fibres around the urethra.

The characteristic discharge and scalding micturition, constitute what is vulgarly called the " clap " in England, and " chaudpisse " in France. Some feverishness may accompany this acute inflammatory stage of gonorrhœa; but often there is little constitutional disturbance. The average duration of this stage is from one to three weeks; its continuance varying according to the number of previous attacks and the habits of the patient.

The *chronic* stage is denoted by the altered character of the urethral discharge; the pus subsides into muco-purulent matter, which is thinner and less copious; and the scalding reverts to smarting or only a soreness in micturition. In about another three weeks the gonorrhœa may pass off—under treatment; but it rarely terminates spontaneously in less than three months. During a severe and protracted gonorrhœal discharge, the general health undergoes a marked depression; so that the individual may be almost known by his haggard, pallid, and listless appearance.

Gleet.—Blennorrhœa or gleet must be regarded as the sequel, rather than the concluding stage of gonorrhœa; for it does not invariably ensue. The urethral discharge has now become a thin, nearly clear and colourless, or almost watery fluid, oozing in small quantity, or so scanty that it has to be pressed out of the meatus for examination; no scalding or other inflammatory symptoms remain; yet this discharge is persistent—lasting for many months, or even years. Thus we speak of an old-standing, gleety urethral discharge. It may be maintained by certain constitutional conditions: a scrofulous, rheumatic, or gouty diathesis; a lymphatic, weakly temperament; or simply by a state of debility. The indulgence in alcoholic stimulants, or in sexual intercourse, or the combination of both sources of urethral excitement in a dissipated life, is equally provocative of continued gleet. The discharge retains its contagious nature for a long or indefinite period; and it is ever liable to be developed into a more virulent puriform secretion by slight exciting causes. Sexual intercourse, therefore, is always unsafe, so long as *any* discharge exists, of whatever kind or as the smallest oozing of secretion.

I have already noticed the *diagnosis* of gonorrhœa from simple urethritis. No positive distinction can be trusted from the appearance of an urethral discharge, its contagious character, or from its having been produced by contagion. As Ricord truly observes, "Gonorrhœa often arises from intercourse with women who themselves have not the disease;" and yet more explicitly, Diday affirms, "that from the very fact of a woman having a discharge, no matter what its origin, she is liable to give a discharge to a man." Bumstead bears similar testimony as to the possibly non-specific origin of gonorrhœa in a man from an uncontaminated woman. It is, therefore, of the utmost social importance not to overlook the difficulty or impossibility of a diagnosis, as affecting the moral character of any woman, and who as a wife or mother would suffer the most wrongful and cruel imputation by a rash or erroneous professional judgment; blighting also the domestic happiness of those with whom they are connected. Nor need I dwell on the further responsibility of the practitioner respecting any such question, when made the subject of Medico-legal inquiry; as perhaps criminally affecting a chaste woman. In the male sex also, *any* persistent urethral discharge—whether from gonorrhœa, as gleet, or of non-specific nature, may equally prove contagious to a woman.

These considerations give a wider significance to the *causes* of gonorrhœa than was formerly understood. Gonorrhœal matter or virus, and occasionally any other discharge—as menstrual fluid or leucorrhœal matter, or even the ordinary uterine or vaginal secretions, may severally communicate, or give rise to true gonorrhœa. The distinction between gonorrhœa and simple urethritis, in virtue of the *specific* nature of gonorrhœal pus, is now generally acknowledged to be no longer tenable. The contagious character of gonorrhœal pus is more virulent, and the symptoms induced are generally more severe; but, from a causative point of view, the only distinction is, that simple urethritis arises from other causes—constitutional and local, as well as from any contagious discharge.

The following additional practical facts, although not perhaps exclusively characteristic of gonorrhœal contagion, appear to be well established: 1. The disease is not communicable by sexual intercourse *before* the discharge appears. 2. Mere contact is sufficient, without any abrasion of the urethral mucous membrane. And contact alone, without any sexual act, may effect contagion (Baumés, Rodet). 3. After the discharge is established, if the urethra be previously washed out by means of a water-injection, the disease will probably not be communicated. 4. The corpuscular element in the secretion is alone the contagium, the filtered fluid being inoculable (Rollet). Hence, the more puriform the discharge, the more is it contagious. 5. The matter retains the power of infection for an indefinite period; in one case Titley found that a girl had communicated the disease immediately on leaving the Magdalen Hospital, after a seclusion of one year; and in another case, according to Hunter, after two years' seclusion. 6. With gleet, two persons thus affected may have intercourse with impunity; but either of them will communicate gonorrhœa to a sound person. 7. The violence of the symptoms depends very much on constitutional conditions, as the gouty diathesis, and habits of life, as intemperance; consequently, the same woman may give a very mild gonorrhœa to one man, and a most severe one to another. 8. The first attack of the disease is generally the most severe; a kind of urethral tolerance—the acclimatization of Ricord—being commonly induced by repeated attacks. 9. The severity and the continuance of gonorrhœa are often inverse; it is most severe in young and plethoric persons, in the gouty or rheumatic diathesis, and in the first attack; but most obstinate in scrofulous and phlegmatic constitutions, in persons affected with chronic skin diseases, and after repeated attacks. 10. The disease seems to be much milder now than formerly.

The *generation* of gonorrhœa, apart from exposure to any discharge, is a question which may be so far entertained that it has not been entirely disproved; but many apparent cases of origin are rendered very doubtful by the persistently contagious character of the slightest gleety discharge. In relation to *syphilis*, the virus of gonorrhœa differs entirely in its nature from that of chancre or of chancroid; neither disease being capable of reproducing the other under any circumstances. The two diseases are distinct; not convertible.

An ordinary case of gonorrhœa passes through an unchequered course, until the discharge runs itself off. But several morbid conditions of the urethra or of adjoining parts may *complicate* the natural history of this disease. *Chordee*, a bent and painful erection of the penis downwards, has been already noticed. Sometimes, instead of the corpus spongiosum being the seat of lymph-effusion, the corpora cavernosa are thus affected, with an upward-arching of the penis, during erection. Occasionally, inflammatory induration of the lymphatics on the dorsum, or on one side of the penis, produces a chordee-like curving-upward, or a lateral twist, of the organ,—apart from an erectile condition. Urethral *hæmorrhage* is apt to occur, from rupture of the engorged vessels during violent erections, and especially in chordee. This event is unimportant; the loss of blood usually being slight, it affords relief. Inflammation and suppuration of some of the *mucous follicles* of the urethra may occasion some temporary obstruction; until the abscess bursts into the urethra, or perhaps externally, as a less favourable issue. Abscess occurs sometimes in the *spongy tissue* around the urethra, in any part of its extent; but more often adjoining the fossa navicularis in the glans, or adjacent to the bulb in the perineum. Peri-urethral abscess, in either situation, may burst into the urethra, or externally, leaving a fistulous opening. Irritation or inflammation of the *urinary organs* is a far more serious complication of gonorrhœa; sometimes affecting the posterior portion of the urethra,—giving rise to severe perineal pain, with spasmodic stricture, and more or less retention of urine; sometimes extending back to the bladder,—as denoted by the more urgent and painful micturition, with mucous deposit in the urine; or there may be the symptoms of renal irritation amounting even to nephritis,—announced by pain in the loins, shivering, vomiting, and albuminous, bloody or purulent urine. This state, with or without cystitis, is likely to be induced by early or strong urethral injections, intemperance, or the use of copaiba in large doses. Inflammation of the *inguinal lymphatic glands*, or *sympathetic bubo*, occurs during the second or inflammatory stage of gonorrhœa. But such buboes rarely proceed to suppuration, unless when subjected to irritation, or in persons of a scrofulous and debilitated constitution. *Balanitis*, an inflammatory affection of the mucous membrane of the prepuce and glans, is known by a thin, opalescent discharge from this part, often profuse and excoriative. Persons who have a long prepuce are most liable to it; but it is engendered by uncleanliness, hot weather, or disordered health. As the result of swelling of the prepuce and glans, *phimosis* or *paraphimosis* is not unfrequently met with in conjunction with gonorrhœa. Thus, the prepuce cannot be retracted, or not easily, behind the glans, so as to uncover it; or, the prepuce cannot be drawn forwards from behind the glans, so as to cover that part of the penis. Various cutaneous eruptions on the prepuce are occasionally concomitants of gonorrhœa. *Herpes præputialis* appears in the form of small vesicles, containing a thin opalescent fluid; and which are disposed in clusters of two, three, or four, upon the internal or external surface of the preputial fold. Roseola, pityriasis, and psoriasis sometimes make their appearance; usually, from six weeks to three months after the commencement of gonorrhœal discharge.

A patient having escaped any mishap in the course of gonorrhœa, is yet liable to the *consequences* of this urethritis. *Orchitis*, or inflammation of the testicle, is not uncommon; commencing as epididymitis, and resulting in a swollen state of the organ. This occurs, according to Fournier, about once in every eight or nine cases of gonorrhœa; and at a period from the third to the eighth week. The inflammation terminates in resolution, seldom in abscess. Both testes are often affected, but rarely at the same time; and there is a liability to relapse. One attack predisposes to another from the slightest urethritis. Gonorrhœal *rheumatism* or *synovitis* may be here mentioned, as another troublesome contingency, to which I shall presently recur more especially. Gonorrhœal *ophthalmia*, an acute purulent inflammation of the conjunctiva, may occur in consequence of the accidental application of the urethral discharge to the eye,—an inoculation of gonorrhœal matter to another mucous membrane. This mode of origin does not seem to be always indisputable; for both eyes are often affected, and usually at an interval of a few days, the eye attacked last generally suffering least. Gonorrhœal *sclerotitis*, an inflammatory affection of the sclerotic or fibrous coat of the eye, may be of a rheumatic character. Occasionally, gonorrhœa or gleet is followed by *prostatorrhœa*, a chronic inflammation of the prostate gland; characterized by the discharge of a few drops of clear, transparent, or slightly turbid viscid mucus, after micturition or any straining effort of defæcation. This fluid is not semen, as it contains no spermatozoa. There is also much irritability about the neck of the bladder, and sensitiveness of the prostatic urethra in passing an instrument; with loss of strength, and mental languor or hypochondriacal lowness of spirits. *Stricture* of the urethra, one of the most ordinary consequences of gonorrhœa, is considered in connection with the general pathology of this disease.

The *treatment* of Gonorrhœa varies according to the stage of the disease.

During the incipient stage—*urethral irritation*—of, say, forty-eight hours' duration, it may be possible to prevent the accession of the inflammatory stage, by means of "abortive" or "revulsive" treatment; which comprises astringent urethral injections, and the specific influence of copaiba or cubebs. But any such agents, if used for that purpose, are very hazardous, by perchance exciting intense inflammation. So far as opportunity may offer for this practice, I believe it is generally abandoned.

Inflammatory stage—acute and chronic.—From the commencement of a gonorrhœal purulent discharge, reducing measures, followed by suppressive injections, may be employed,—according to the degree of urethral inflammation. When *acute*,—with an abundant, thick, opaque, yellow, or creamy discharge, and scalding in passing urine—the appropriate treatment consists in gentle saline, alkaline, aperient medicine, an unstimulating diet, abstinence from wine, beer, or spirits, with rest and recumbency. As a topical application, immersion of the penis in very hot water, for a few minutes, is said to afford great relief; and Fournier recommends a similar application of cold water; so, therefore, the sufferer may make choice of either luxury. When the inflammation has passed into the *chronic* stage,—with a diminished, thinner, and clearer discharge, and the absence of scalding in micturition—the previously reducing measures should be discontinued; and succeeded by acid tonics, or perhaps copaiba or cubebs, and astringent urethral injections may be used. In *gleet*,—the discharge having now become scanty, thin, clear, and colourless, as a watery oozing from the urethra, and lasting for a considerable period—the same suppressive measures will also be appropriate.

By the foregoing plan of treatment, I have almost invariably prescribed with success, in some thousands of cases. Commencing with an aperient and alkaline mixture,—containing sulphate of magnesia, in about drachm doses, with a little senna, and the bicarbonate of potash, or the sesquicarbonates of soda and ammonia, in doses sufficient to nearly neutralize the urine; in three weeks or more, the urethral inflammation will have safely subsided; the patient having abstained from any indulgence in wine or other alcoholic beverages, and stimulating food, especially peppers and condiments, any sexual excitement, and active exercise. The discharge has now undergone the characteristic change in quantity and appearance to that of the chronic stage; and the scalding pain in micturition has also ceased, leaving only a slight smarting or soreness in passing urine. *Then*, the discharge may be *safely* suppressed, gradually, by using an injection twice a day; consisting of about ʒij of the liquor plumbi diacetatis to ℥ij of distilled water. Other injections, if not preferable, may be preferred. Thus, the subnitrate of bismuth in mucilage, grs. x to ℥j of water, with a little morphia or belladonna; nitrate of silver, grs. i—ij to ℥j; chloride of zinc, grs. i—iv to ℥iv; sulphate of zinc, gr. i, gradually increased to grs. iv to ℥j; sulphate of zinc and acetate of lead, ana grs. xxx to ʒvj, an injection long in use at the old Lock Hospital; or acetate of zinc, grs. xii to ʒiv of water, the favourite injection of Sigmund, Milton, and Bumstead; alum *exsic*, grs. v—x to ℥i; forms another useful astringent; or tannic acid solution of the same strength. In obstinate *gleet*, the bichloride of mercury may prove successful, gr. $\frac{1}{4}$ to ℥j of water; and other approved formulæ are: sulphate of copper, gr. i to ℥j; permanganate of potash, gr. i—iii to ℥j; or that which Bumstead recommends, the persulphate of iron, ʒſs to ℥vi of water. Before using any injection, the patient had better pass his urine, in order to clear the urethra of gonorrhœal matter, which would prevent contact with the mucous membrane; and also to avoid the necessity of emptying the bladder again for some time, care being taken to drain away any urine from the urethral canal. These two latter precautions have regard to any decomposition of the injected solution by the action of the urine. Owing to such a change, a lead-injection becomes opaque and curdled when discharged; and nitrate of silver acquires a milky-white opacity; both solutions having been made with distilled water. An injection is thrown up the urethra by means of a small glass syringe; and so that it shall be applied only to the affected portion of the urethral tract, the finger is placed under the canal just in front of the scrotum. For deeper injection, as mostly in gleet, various forms of catheter-syringe have been devised, principally by Tiemann. Astringents in the form of powder can be injected to any particular part of the urethra, by means of Mallez's breech-loading metallic tube; but such localized application will rarely be appropriate. No injection should cause pain, but only a feeling of warmth or smarting, and which ceases in a few minutes. Bougies, besmeared with an ointment of nitrate of silver, or the balsam of copaiba, may be passed along the urethra; but this mode of making topical applications is not in general use. In old-standing *gleet*, introduction of a bougie, or preferably, a cold-steel sound, occasionally, even where no stricture exists, is highly beneficial. It should be of sufficient size to occupy the urethra without distending the passage; be left in for about ten minutes at a time, and be passed twice or thrice a week, taking care never to re-introduce any instrument until irritation and increased discharge shall have passed off for twenty-four hours. Blistering the penis, in obstinate gleet, has found favour with some Surgeons; the unguentum lyttæ spread on lint, is wrapped around the body of the organ, and applied for not longer than two hours. The effect is said to be singularly curative, when the gleety discharge is uncomplicated by stricture or orchitis. Sometimes, a congenitally small urethral meatus maintains an obstinate discharge; a small pouch having formed behind the lower commissure of the orifice, into which a bent probe can be introduced. A slight incision in this direction will relieve the meatus, and soon stop the gleet.

The medicinal treatment of chronic suppurative discharge, and of watery gleet, is best fulfilled by an acid-tonic mixture of cinchona with sulphuric acid; but towards the close of the case, sulphate of iron should be given, to repair the anæmic condition. Such treatment as may be suitable in the various other constitutional conditions, must not be overlooked; as in the scrofulous, rheumatic or gouty diathesis, on which a gleety discharge may depend. Certain medicinal agents have apparently a *specific* influence in arresting the discharge, and especially the two renowned specifics—copaiba and cubebs. Some Surgeons urge the employment of these medicines in the acute stage of gonorrhœa. Neither should be administered when it manifestly disagrees with the patient; nor continued on trial beyond a week or ten days, when no beneficial effect has been obtained by that time. Both these specifics are apt to disturb the digestive organs, and produce symptoms of renal irritation; and copaiba sometimes induces a cutaneous rash, in the form of small red patches, more or less circular, somewhat like nettle-rash; or it may occasion headache and vertigo. But the various *preparations* of these medicines are not equally to be commended. Copaiba may be given in capsule, pill, or draught. The capsule, an envelope or coating of gelatine, containing a small bolus of copaiba, is an elegant and convenient preparation; the envelope disguising the nauseous taste and peculiar odour of the balsam. Six or eight capsules may be taken daily. The French dragées are also much used, particularly in America. In the form of pill, consolidated with magnesia, copaiba sometimes acts more effectually, a drachm being taken thrice daily; or combined with dilute sulphuric acid, fifteen minims, and mucilage in infusion of roses, as a mixture, this medicinal agent is better tolerated by the stomach. Cubebs may agree when copaiba will not. The dose of the powder is a drachm, three times a day. The fluid extract, in similar doses, is more palatable. But the oleo-resin is the most active preparation; and given in capsule containing ten drops, one, two, or three may be taken, according to the effect of this remedy. Any specific, or any injection, that may be employed, had better be continued for a week or ten days after the discharge has ceased; although a slight oozing may perchance be maintained by prolonged injections. Both specifics are sometimes advantageously taken together, in such proportions as to form the consistence of an electuary; of which a drachm will be the dose, thrice daily. I never find it necessary to prescribe either copaiba or cubebs, and have for some years discarded them. More recently, the oil of yellow sandal-wood has come into use as a specific; ten to twenty drops being given on a lump of sugar, or in capsule, and the dose increased when this remedy agrees with the stomach, although it is apt to induce pain in the loins. In the course of a week, with full doses two or three times a day, the curative effect will be attained. All these specifics operate through excretory changes in the urine, directly acting on the inflamed urethral mucous membrane, by contact from micturition. Hence, they are inert in the female, unless the urethra be involved in gonorrhœa—as affecting the vagina. In concluding the treatment of gonorrhœa, hygienic resources may prove singularly beneficial. The tepid or cold sponge-bath, with friction afterwards, sea-bathing, an open-air life, avoiding horse-exercise, will often succeed in finishing off an otherwise lingering case. Smoking should be prohibited. As any persistent urethral discharge might be contagious, sexual intercourse must be strictly forbidden.

Chordee is best prevented or overcome by a nightly pill of opium and camphor,—say gr. i to grs. ii, as an anodyne antispasmodic, or conium and camphor in pill, I have often ordered with marked relief. Camphor alone may be taken, as Mr. Milton directs; one drachm of the tincture in water, before going to bed, and repeated every time the patient wakes with chordee. Or Ricord's suppository,—of opium, the watery extract, gr. i, with camphor grs. x, may be introduced into the rectum an hour before bedtime. The patient must deny himself supper or any excitement before going to bed, and then bathe the parts with cold water, or better, with hot water until a sensation of faintness is produced; he should lie on a hard mattress, and be lightly covered with bedclothes. If the sufferer from chordee be tempted to forcibly straighten the penis—"to break the chordee," he will indeed obtain immediate relief, but at the expense of a traumatic stricture in consequence; and of which, therefore, he should be warned.

In the event of urinary *retention*, from spasmodic stricture, the warm bath and a full dose of opium, repeated as may be necessary, will probably soon give relief. But, with symptoms of prostatitis or of cystitis, these measures must be followed up by hot fomentations over the bladder, and topical blood-letting, fifteen or twenty leeches to the perineum. The urine should be kept neutral and diluted by alkaline drinks.

Gonorrhœal *epididymitis* and *orchitis* may be treated by rest in the recumbent position, warm fomentations, and leeches if necessary; but sedative measures, especially hyoscyamus in full doses, with camphor mixture, will often prove sufficient to subdue the pain and swelling of the testicle; while, if the urethral discharge has been suddenly suppressed, I am in the habit of soliciting its return by enveloping the penis in a poultice.

Gonorrhœal *rheumatism* is an inflammatory affection, which bears a general resemblance to ordinary rheumatism, but which arises from gonorrhœal urethritis. It attacks the *synovial* membrane, or the synovial sheaths of tendons, and sometimes the bursæ; or it may affect the *fibrous* textures, as the fasciæ and sheaths of muscles, or possibly of the nerves, and rarely visits the pericardium or endocardium, the testes, or the eyes. In the form of *synovitis*, the inflammation is marked, usually, by an abundant serous effusion into the capsule, constituting *hydrarthrosis;* it is attended with little pain, unless after moving the joint, and there is no heat or redness of the integument. The disease terminates by resolution, without any disorganization of the joint, or it proceeds to fibrous anchylosis; occasionally to *suppuration*, and destruction of the joint. In either of these states, the affection is of an indolent character, lasting for weeks or months, perhaps a year or two. Commonly, the knee-joint is attacked, the ankle or elbow less frequently; but any joint is subject to gonorrhœal synovitis. Where a large joint is attacked, only one is affected; sometimes two, as both knees. The *fibrous* form of gonorrhœal rheumatism is manifested by pains, more or less severe and fixed, or wandering, in various muscular parts of the body; as in the shoulders and back, or in the thighs and legs. Lingering as an obstinate complaint, there is no tendency to suppuration.

In both these forms of the disease, the disproportionately slight febrile disturbance is even more diagnostic from that of ordinary rheumatism, than the comparatively painless character and absence of acute inflammatory symptoms, in the synovial and fibrous affections. The pyrexia is unattended with the profuse and acid sweatings of rheumatic fever, and the urine undergoes no marked changes of hyperacidity or deposit of lithates. The blood—when drawn and coagulated—scarcely exhibits the buffy-coat; and there is not the same hyperinosis, or excess of fibrine, as found in rheumatic pyrexia.

The complications of pericarditis and endocarditis are almost unknown in this disease.

In tracing the *causes* of gonorrhœal rheumatism, exposure to cold and moisture has no tendency to beget an attack, even in persons of a pronounced rheumatic diathesis,—unless there be a co-existing gonorrhœa. The disease is thus distinct in its etiology from ordinary rheumatism. Some peculiar predisposition must exist, as evinced by the small proportion of persons who become affected in the course of gonorrhœa; but the occurrence of one attack entails a singular liability to repeated attacks, whenever the individual acquires gonorrhœal urethritis.

The causative relation of the urethral discharge to the production of a rheumatoid attack, has not been satisfactorily determined. Commencing—according to Fournier's observations—between the sixth and fifteenth day of gonorrhœa, and rarely at any later period, as the second or third month of chronic discharge or gleet, the rheumatoid disease is not generally preceded by an arrest or any diminution of the discharge, and when arising from gleet, an actual increase of the secretion occurs before the supervention of synovial inflammation. Gonorrhœal rheumatism, therefore, would not appear to be a sudden *metastasis* of the urethral inflammation; and the same order of events would seem to preclude *pyemic infection* from the urethral discharge. Sometimes, however, the discharge stops abruptly, just before a rheumatoid outbreak; and it always declines or disappears after the development of rheumatoid symptoms. Thence the possibility of either mode of origin—metastasis or pyemic infection, at least in such cases.

The *treatment* of this disease is similar to that for rheumatism, of a subacute or chronic character. Experience has attested the remedial efficacy of alkalies with colchicum, or of iodide of potassium with tonics, in the form of quinine especially. The marked anæmia which supervenes in advanced cases, will suggest the use of the sulphate of iron, and other ferruginous preparations. Mercurials, particularly the bichloride of mercury, may be advantageously conjoined with the ordinary treatment, in cases where a syphilitic taint is associated. Cod-liver oil often improves the defective nutrition witnessed mostly in scrofulous subjects. The joint affections yield slowly to rest with counter-irritation, and the support of strapping; while muscular pains and stiffness may be dispersed by frictions, or in due time, passive movements, and the influence of galvanism. The urethral inflammation is to be treated as usual; and no attempt should ever be made to re-induce the discharge.

Urethral Lesions.—In the development of gonorrhœa, the urethral inflammation commences at the meatus, and passes backwards slowly, reaching even to the bulb, and perhaps involving the prostate, seminal vesicles, and bladder. Examinations with the endoscope, by Desormeaux, have demonstrated the changes which the urethral mucous membrane presents, in the successive stages of gonorrhœa. On the eighth day of the discharge, the inflammation has extended to the anterior half of the urethra; the membrane is congested, and has lost the polish of epithelium, being beset with little denuded spots. In a more advanced stage, the posterior half of the membrane has become invaded; but the inflammation tends to assume a localized form—in the fossa navicularis, the sinus of the bulb, or in some intermediate part where chordee exists. These *patches* of inflammatory congestion are not only denuded of epithelium,—they may be covered with granulations, having the same appearance as that of granular lids from conjunctivitis, or even present the character of polypoid excrescences. This localized state of gonorrhœal urethritis is especially coincident with *gleet*—the congested, and perhaps granular, patches of mucous membrane maintaining the serous, or puriform, discharge. At some part, where the inflammation has been more intensely concentrated,—as towards the urethral bulb,—the submucous tissue is infiltrated, and becomes thickened, so as to form an organic stricture; this also being the source of gleety discharge.

Urethral examination may be made by means of a bulbous bougie, or with the endoscope. On passing a full-sized instrument, having a bulbous end, down the urethra, a congested or granular spot may be detected by the painful sensation elicited when the instrument reaches that spot, and which ceases as the instrument passes beyond into healthy urethra again. Sometimes, before any disturbance of the urethral passage by an instrument, some evidence, as to the existence of a congested patch, may be derived from examination of the urine. During micturition, the surface of any such patch is washed by the flow of urine; and thus a sort of soft scab of adherent pus-corpuscles may be detached, which being twirled round in the stream, is brought away in a filamentous form. On examining the urine, immediately after its transmission into a glass vessel, one or more of these filaments will be seen sinking in the fluid; and if a filament be caught and placed under the microscope, its nature will be at once discovered—it being found to consist of adherent pus-corpuscles. The difficulty, however, of distinguishing between these cells and mucous corpuscles, renders the evidence thus obtained ambiguous. The shred-like character of the desquamation points to an urethral lesion—in the state of an abrasion, which is destitute of the ordinary columnar epithelium of the urethra. In the diagnosis of a congested patch at any part of the canal, the escape of a thready shred might proceed from the mucous membrane behind a *stricture;* but then the existence of this urethral condition will be detected in passing an instrument. Examination with the *endoscope,* or urethral speculum, may be resorted to, if necessary, to settle any diagnostic difficulty. A congested or granular patch can be plainly seen, as the end of the tube traverses the urethra.

The *treatment* of any such lesion consists in the topical application of various stimulant solutions, usually by means of a long fine probe, armed with a twist of cotton saturated with the solution. Nitrate of silver, sulphate of copper, or tannic acid, will each prove remedial, in different cases; when one fails, another stimulant succeeds. And much stronger solutions can be applied topically through the endoscope, than could otherwise be used; the urethral mucous membrane in front of the lesion being protected by the tube.

The application is to be renewed once or twice a week, as occasion requires, after any painful sensation has worn off; and this method may have to be continued for some months, until the patch of mucous membrane has resumed a healthy appearance. In the course of treatment, the endoscope enables the Surgeon to ascertain the progress effected, and when a cure is attained.

Gonorrhœa in the Female is a much less common affection than in the male sex. But the inflammation and discharge is rarely restricted to the urethra; the vagina is the chief seat of gonorrhœa. The symptoms are heat and itching in the vagina, with smarting or scalding in the urethra when the urine is passed; on examination, the vaginal passage is found to be red and swollen; these early symptoms being soon followed by a copious, greenish-yellow, muco-purulent discharge, proceeding more especially from the upper wall of the vagina. The labia usually become involved, appearing red and puffed, while the secretion from the sebaceous follicles gives an offensive character to the discharge. Sometimes the inflammation extends backwards to the os uteri, which presents small patches of superficial ulceration, accompanied with discharge from the cervix. Thus the gonorrhœal inflammation affects an extensive tract of mucous membrane, in the form of vaginitis and vulvitis, with urethritis; while the perineal and anal integument has often a reddish, excoriated appearance from the irritant nature of the discharge. But all the symptoms are usually milder than in the male; and although perhaps of longer duration, the discharge does not generally pass into gleet. *Simple* vaginitis must not be mistaken for gonorrhœa; and yet their *diagnosis* cannot be determined by any one symptom, or by the combination of symptoms, nor by the appearance of the discharge or its inspection with the microscope. This absence of any distinctive evidence is a very important consideration in relation to medico-legal inquiry respecting supposed gonorrhœa in young females and children; who are very liable to simple inflammation of the vagina from various causes, both constitutional and local. The diagnosis is scarcely less doubtful with regard to vaginal *uterine* discharges, at any period of life.

Fewer untoward events are likely to *complicate* the course of the disease in women than in men. Not unfrequently one of the swollen labia suppurates, the abscess pointing on the inner side. There may be some inguinal sympathetic bubo, but almost only in cases where the urethra is affected; and sometimes the vaginal inflammation creeps up to the cavity of the uterus, and may even pass up the Fallopian tubes to the ovaries; the ovaritis thus induced corresponding to epididymitis in the male. Gonorrhœal rheumatism is a rare occurrence, and gonorrhœal ophthalmia is seldom met with.

Treatment may be comprised in a few words. During the inflammatory stage, saline, alkaline aperients should be given, and an unstimulating diet enjoined, with rest and recumbency. The pain and swelling may be subdued by warm, anodyne fomentations; or cold, sedative applications may be preferable. Thus, flannels steeped in decoction of poppyheads, or weak lead lotion, afford relief; and similar injections will allay the original inflammation. In the chronic stage, no special remedial measures are requisite, but the topical applications must be made directly to the part affected. Thus, injections must be thrown up the vagina so as to reach the seat of inflammation, and lotions should be applied by means of a fold of lint placed well in between the labia. Of astringents, I prefer the diacetate of lead to the sulphate of zinc, alum, or other solution; ordering the former in the proportion of an ounce or more of the liquor plumbi to a pint of water, to be injected with a rose-topped syringe, two or three times a day. Nitrate of silver, two or three grains to the ounce, was recommended by Carmichael and Ricord. Plugging the vagina with lint dipped in the lotion, will often prove more efficacious than injection; partly by separating and insulating the diseased portions of the mucous walls. This dressing must be reapplied night and morning. Uterine gonorrhœa may be treated by exposing the os with a speculum; then, having mopped away the discharge with a piece of sponge introduced by a long forceps, the mucous membrane of the os and cervix should be cauterized or lightly pencilled with nitrate of silver. Specifies, as of copaiba or cubebs, can be of no service in the gonorrhœa of women, unless the urethra be affected; these medicines acting through the urine.

STRICTURE OF THE URETHRA.—Among diseases of the urethra, Stricture justly ranks high in its importance; whether on account of its frequency, the distress it occasions, the serious and fatal consequences when neglected, or the unquestionable means for cure or relief.

The term Stricture of the Urethra signifies an unnatural narrowing or contraction of this passage, at one or more points in its extent. This may depend on either of three distinct conditions:—(1) Lymph-deposit in the mucous and submucous tissues, as the result of chronic inflammation—and thence known as Organic or Permanent Stricture; (2) Spasmodic contraction of the muscular fibres encircling the mucous membrane—Spasmodic Stricture; (3) Inflammatory congestion of the mucous membrane—Inflammatory Stricture. The two latter conditions of stricture—spasm and inflammation, often coexist; and either may be engrafted, for a time, on organic stricture.

ORGANIC OR PERMANENT STRICTURE.—Four forms of organic stricture of the urethra may be recognised, according to Sir H. Thompson's accurate observations: —*linear* stricture, in which the urethral canal is obstructed by a thin, membranous septum, having a central aperture; or a crescentic septum, which obstructs a segment only of the calibre of the canal, thus forming the "bridle stricture;"—*annular* stricture, a thicker and broader, contracted portion of the urethral canal, as if a piece of cord had been tied around it at one point, leaving the remainder free (Fig. 42) ;—*indurated annular* stricture, a more confirmed contraction, in which the induration involves the tissues of the urethra to the depth of half a line or line; it is limited in length from before backwards to less than half an inch of the canal, having extended from the original point of contraction, backwards and forwards, but sloping off in either direction, and thus forming an hour-glass contraction, usually thicker on the floor than at the upper aspect of the urethra;—*tortuous*

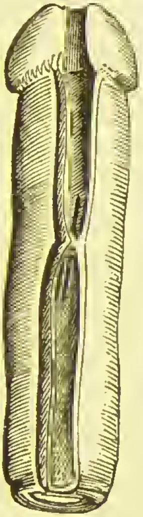

FIG. 42.—St. Thomas's Hosp. Mus., DD. 44. Annular stricture of the urethra, situated in the spongy portion, nearly three inches from the external meatus.

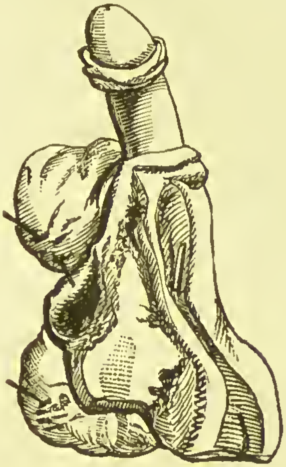

FIG. 43.—Roy. Coll. Surg. Mus., 2,552. Long, narrow stricture of the membranous urethra, and in the first inch of the bulbous and spongy portions; with a false passage just in front, and a large irregular abscess in the perineum, having numerous fistulous openings,—perineal, scrotal, and in the right buttock; but the abscess does not communicate with the urethra. (Hunterian.)

or irregular stricture, owing apparently to adhesion of the rugæ of the urethra, to a short extent, or to a cicatricial patch of induration, or a longitudinal contraction and induration to an extent of one or more inches (Fig. 43). In this condition of stricture, the induration may involve the entire substance of the corpus spongiosum, presenting the most obstinate and undilatable form of stricture.

Situation of Stricture.—The urethral canal is liable to stricture in three situations:—(1) At the junction of the spongy and membranous portions, or within an inch before, and three-quarters of an inch behind, that point. Of these situations, the most common seat of stricture is the bulbous part of the spongy portion, or in the membranous portion, anterior to the triangular ligament, rarely behind, and most rarely as far back as the posterior part of the membranous portion. No instance has been found of stricture of the prostatic portion of the urethra. The above strictures correspond to the sub-pubic curvature.

(2) In the centre of the spongy portion, or that portion of the urethra which extends from the anterior limit of the preceding to within two inches and a half of the external meatus, a length of about three inches.

(3) At the external orifice, and within a distance of two inches and a half of it. In many cases, stricture in this situation is attended with phimosis, and adhesion of the mucous membrane of the prepuce to the glans penis. Such strictures are mostly congenital.

These definitions as to the situations of urethral stricture result from a laborious examination by Sir H. Thompson, of 270 preparations in our principal public museums, and comprising 320 distinct strictures. In region (1) were found 215, or 67 per cent. of the entire number; in region (2), 51, or 16 per cent.; in region (3), 54, or 17 per cent. Mr. H. Smith made a similar investigation of this question, on a smaller scale; the preparations numbering 98, as preserved in the different London Museums. Of these, 77 were strictures situated anterior to the triangular ligament; and 21 only, in the membranous portion of the urethra.

Several strictures may coexist in the same urethra; John Hunter records an instance of six strictures in one urethra; Lallemand and other French writers describe seven or eight; Sir H. Thompson has never been able to find any such examples, and he limits the highest number of coexisting strictures to three, or the most four. In the above number of 270 preparations, 8 were cases of stricture in all three regions; 10 in regions 1 and 2 only; 10 in regions 1 and 3 only; 13 in regions 2 and 3 only.

The urethral obstruction occasioned by stricture gives rise to *symptoms* which are individually, or collectively, significant of this condition. Increased frequency of micturition arises, owing to the inability to completely empty the bladder; the stream of urine becomes smaller than is natural to the individual, and altered in form, being either flattened, twisted or corkscrewed, forked, or turned aside; and discharged with a less forcible propulsion, so that the current is not ejected as far from the person as formerly, and at length issues as a mere dribbling or in drops. But the stream varies much from time to time, as attacks of urethral spasm supervene;

from errors of diet or exposure to cold; causing even temporarily complete retention of urine. Usually consequent in gonorrhœa, some such symptoms of stricture generally occur within a year of the attack; but when resulting from injury to the urethra, the symptoms commence at an earlier period—about four months.

As the obstruction *increases*, the muscular coat of the bladder gradually strengthens and hypertrophies, in order to compensate for the difficulty in ejecting the urine through the strictured urethra; and as this thickening of the bladder proceeds, its capacity is proportionably diminished, less urine can be retained, and micturition must be even more frequent. This state, annoying and inconvenient during the day, is distressing at night, when exhaustion would invite to rest; the sufferer being repeatedly aroused from his temporary doze, and the night passed in restless efforts to obtain relief. After each act of micturition is apparently completed, another significant symptom is experienced; a certain portion of urine still escapes as a dribbling leakage, owing to the propulsive force of the remaining urine being insufficient to overcome the resistance of the stricture, which was dilated by the stream passing when the bladder was full. After the act of micturition is actually quite finished, a certain portion of urine can sometimes be squeezed out by pressure behind the seat of stricture, from the dilatation of the urethra in that situation. This dilatation increasing, may at last attain to such size as to present a tumour in the perineum, during micturition; a fluctuating swelling the size of a small orange having been thus produced, in a case under the care of Sir B. Brodie. At the seat of stricture, more or less enlargement and induration of the urethra may be felt—usually therefore in the perineum behind the scrotum. Pain is usually felt in the canal behind the stricture, during the effort to pass urine; and by constant straining, some feculent matter or flatus escapes at such times, and a tendency to prolapsus of the bowel is established. In a paroxysm of straining effort, rupture of the urethra may occur, behind the stricture; and then extravasation of urine takes place into the cellular texture of the perineum, scrotum, and supra-pubic region. But it not unfrequently happens that this results from abscess forming in connection with the same portion of the urethra. In the act of coitus, much pain is experienced about the ejaculatory ducts; and, as the semen escapes with difficulty through the urethra but passes back into the bladder, there may be no seminal emission; and the unhappy patient believes himself actually, as he may be virtually, impotent. The urine undergoes those changes which result from chronic cystitis, consequent on retention. It becomes ammoniacal, cloudy, and deposits more or less mucus and pus, with phosphates. Hæmaturia is an occasional concomitant of stricture; the blood coming from the mucous membrane of the bladder, or perhaps from the urethra after catheterism or an erection of the penis affecting the seat of stricture. A gleety discharge not unfrequently attends old stricture of the urethra. The genital organs are affected by the more or less constant retention of urine. Congestion of the penis occurring from straining micturition, the organ becomes enlarged and somewhat indurated, and sometimes the prepuce is œdematous. From irritation of the prostatic urethra, epididymitis not unfrequently occurs, perhaps on both sides, resulting in knotty induration of the part; and the canal sometimes becoming obstructed with deposit, sterility ensues. In elderly men, attacks of prostatic congestion aggravate the retention; and may at length give rise to inflammation and prostatic abscess. So far as mere enlargement of the prostate obstructs the passage of urine, there is less tendency to spasm affecting the stricture, as the force of the stream is diminished in the act of micturition; but when abscess supervenes on the enlargement, the inflammatory irritation extends along the urethra and provokes spasm.

The general health fails, the patient losing flesh and strength; he has an anxious and careworn appearance, suffers from pains in the loins, lower part of the belly, the perineum and testicles; and is subject to severe attacks of rigors. Any irritation of the urethra, as by passing an instrument or the application of an irritant substance, will often provoke such an attack, especially in those who have lived in hot climates, or it not uncommonly excites general feverishness—hence named "urethral fever," and which has sometimes an intermittent character.

Certain *varieties* of organic stricture may be recognised by some peculiarity of their respective symptoms.

Simple stricture; chiefly denoted by diminution in the size of the stream of urine, with the other ordinary symptoms of stricture.

Sensitive or *irritable* stricture.—Proneness to disturbance of the nervous system, as manifested by chilliness or rigors on very slight urethral irritation; and pain, sometimes persistent, from the gentlest passage of an instrument. A disposition to hæmorrhage is evinced in a few cases.

Contractile, resilient or *recurring* stricture—distinguished by a constant tendency to further diminution of the urethral canal, in the absence of treatment; and contraction recurs rapidly after dilatation has been effected. Traumatic stricture often has this character, and the same condition may result from the use of strong injections.

Examination of the Urethra.—Catheterism, or what I would term bougieism—the use of a bougie—supplies the most direct and conclusive evidence as to the existence of stricture; evidence analogous to that of sounding for stone in the bladder. The presence of stricture, its situation, its calibre, the extent of the canal involved, and the amount of induration, may be thus severally determined; and whether also there be one or more strictures. Instruments of various composition and form are used for this purpose; *catheters*, which may be inflexible as the ordinary silver instrument, or flexible gum-catheters; and *bougies*, which are solid instruments of flexible metal, or flexible and more or less elastic, as the ordinary gum-elastic bougie, wax, or catgut bougies. *Sounds* are also employed, which being inflexible, solid metallic instruments, are stronger than any metal catheter of small size; and the steel sound admitting of the highest polish, is the smoothest instrument for use. Catheters may be curved or straight. The former shape is generally applicable: and the curve most commonly suitable, is that which corresponds most nearly with the bend of the urethra at its inner third—an arch rather less than one-fourth of the circumference of a circle $3\frac{1}{4}$ inchos in diameter. Straight instruments are preferable for strictures in the ante-scrotal portion of the urethra.

Probe-pointed catheters, metallic or flexible, are more penetrating instruments (Fig. 44). An inflexible one, therefore, must be used cautiously. Sir H. Thompson's catheter of this kind, as modified by Otis, is the best; the eye-portion, above the conical end, was liable to break; but an opening having been made at the end instead, the instrument can thus be used also to follow a whalebone filiform-bougie. The *probe-pointed steel stricture-staff*, such as that used in perineal section, affords the surest indication as to the situation of stricture in the course of the urethra; the shoulder of the instrument being arrested by the constriction, its anterior limit is thus declared. At the same time, on passing the finger into the rectum, the narrow portion of the staff can be felt to have passed through the stricture,—at the membranous urethra.

The *bougie olivaire* (Fig. 44) possesses two advantages; a bulbous or spear-headed end, and flexibility; it can, therefore, be insinuated, or passed with a screw-like action, into a tight stricture, and readily takes the course of an irregular urethra—without causing a false passage, pain, hæmorrhage, spasm, or rigors. This instrument, invented by Lioutt, and originally advocated by Mr. Teevan, in this country, is now much used. The *bougie à boule*, having a conical-shaped extremity, is another flexible and elastic instrument of much use in the diagnosis of stricture. *Sounds* are made with either rounded or conical ends; the latter so far resembles a conical bougie; but the inflexible nature of a solid steel sound with a probe-point, renders this instrument fitted only for the penetration of a tight stricture. By using a stylet which shall completely occupy the bore of a

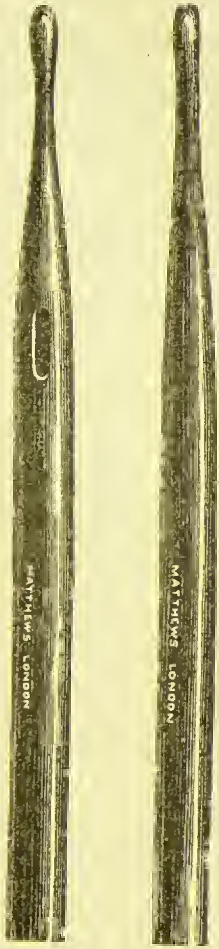

Fig. 44.

probe-pointed catheter—as Otis suggested—that instrument becomes equivalent to a solid probe-pointed sound.

The *introduction of a catheter* may be performed in either of two ways; in the recumbent position, and with the curve of the instrument directed upwards; or in a standing position, and with the curve of the instrument looking downwards. Of these two methods, the former is usually more easy and convenient both to the patient and Surgeon. The patient lying down on his back, with the shoulders a little raised, the legs thrown easily apart, and slightly drawn up; an instrument of appropriate size—No. 7 or 8—is selected, and warmed by a little friction up the sleeve for a few seconds, and then oiled or smeared with lard. In introducing the catheter, the handle should be held lightly between the thumb and the fore and middle fingers of the right hand—the concavity of the curve looking upwards towards the left groin of the patient, and the direction of the instrument being nearly horizontal. Raising the end of the penis with the thumb and finger of the left hand, so as to draw it up to its full length; the double curve of the urethral passage, somewhat resembling an italic *S*, is thus changed into one curve, commencing from just in front of the scrotum; and this single curve corresponds to the curve of the instrument, as it passes along the urethra from that point downwards and upwards into the bladder. The point of the instrument—held as directed—is now inserted into the urethral meatus and carried slowly onwards along the floor of the canal, to avoid the lacunæ on its roof, until four or five inches have disappeared; the handle is brought, at the same time, to the middle line, but still parallel and near to the patient's abdomen; then it should be gently raised, and as the point of the instrument passes under the subpubic curve, the handle is carried forwards and lightly depressed until it sinks below the horizontal line, when the opposite end will turn upwards into the bladder (Fig. 45). After the point of the instrument has passed below the scrotum, its further progress in the right direction may be facilitated or maintained, by guiding it between the fore and middle fingers of the left hand, under the pubes; and sometimes, the introduction of the forefinger into the rectum will aid in determining the middle line onwards to the bladder. That the bladder

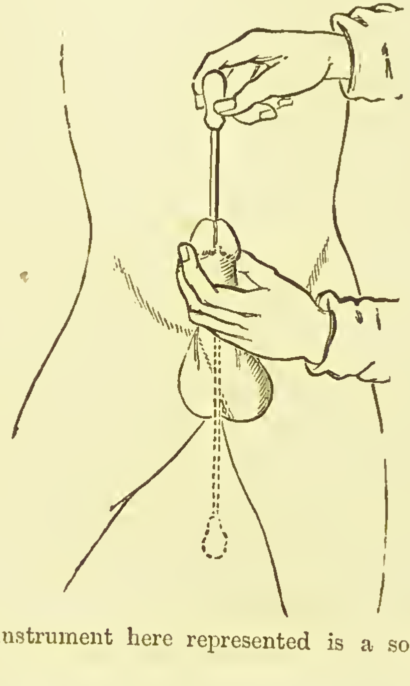

FIG. 45.—The instrument here represented is a sound, instead of a catheter.

is entered is announced by some escape of urine through the catheter, on withdrawing the stylet, and by freedom of the point on attempting to rotate the instrument from side to side. But, no urine will escape, when there is only a small quantity, in the lower fundus of the bladder, and the patient recumbent; and I have noticed, that, in the sitting or standing position, there may be a small or dribbling stream, even when the bladder is nearly full, owing apparently to temporary atony or paralysis of the organ. After a few minutes, the urine may be drawn off freely, or discharged in a full stream. The instrument is withdrawn slowly, and without force, the hand-end being raised upwards towards the abdomen again, as the point of the curve returns under the sub-pubic arch. In passing a catheter, any slight resistance may be obviated by manipulating the instrument, in respect to its direction, or withdrawing it for an inch or so, and then re-passing it. Thus the point of the instrument may be released, when caught in a lacuna, or re-directed when arrested by the triangular ligament, on passing through the narrow membranous urethra in the sub-pubic arch. There also the grasp of spasmodic contraction may be chiefly felt, and is to be overcome by resting the point of the catheter against the obstruction for a minute or two, until the spasm relaxes. Obstruction in this situation will be noticed by bulging of the perineum, from the convexity of the instrumental curve. A flexible catheter or bougie produces no projection, when the instrument is obstructed in its passage; but as the shaft doubles up, the urethra is distorted, and the hand-end rebounds. The presence of *stricture* is determined by an arrest of the instrument point-blank, and at the same part of the urethra on each re-introduction. If, sometimes, the point of the instrument be only stuck in a lacuna or some fold of the mucous membrane, the point will feel loose, and should be disengaged; whereas, when it has entered fairly into the stricture, the point is felt to be grasped tight, and then it should be gently urged onwards. Remembering the situations of stricture, this obstruction will be found usually behind the scrotum, in the sub-pubic curvature; less frequently in the ante-scrotal portion of the urethra. No force should ever be used, nothing more than the pressure of a light hand, exercised slowly, continuously or intermittently, and with patience. Any departure from this injunction may lead to perforation of the urethra and the formation of a "false passage;" and this misadventure is the more likely to happen while the handle of the instrument is being depressed, whereby the shaft acts as a powerful lever on the point in the urethral passage.

The other method of introducing a catheter—when the patient stands upright—is performed in the *opposite* manner to that in the recumbent position. It is the "tour de maître" of French authors. The patient standing with his back to a wall, so that the nates shall not recede during the procedure, and with his legs a little apart; the instrument is introduced with the curve looking downwards, and the handle in a perpendicular line beneath, the penis being drawn straight forward. Having passed the instrument in this direction as far as the sub-pubic arch; it is swept round to the right and raised upon the abdomen, thus describing a semicircle, of which the catheter-point is the centre; then the handle is gradually depressed, so as to carry the point of the instrument through the sub-pubic curve into the bladder. I have never found any manipulative advantage in this method of catheterism; and if the patient should suddenly become faint—as often happens when the urethra is sensitive, some damage may be done to the passage, before the instrument can be withdrawn, as the patient slides down to the floor, or perchance falls over the Surgeon—which I have seen occur.

The *existence* of stricture having been ascertained by the obstruction offered, at some point, to the introduction of a catheter along the urethra; its *situation* may be estimated by feeling the end of the instrument behind the scrotum, or in front as the case may be, and noted more accurately by the length of the instrument passed from the external meatus. The *degree* of contraction or the calibre of the canal at that point can be estimated by the size, or number, of the instrument used; the *extent* of the canal involved, by the length of the instrument "held" or "grasped" from the point of entering the narrowed portion of the urethra; while, at the same time, the amount of *induration* may be judged of by an experienced tact. To measure the amount of constriction, Otis has devised a "urethrometer;" an instrument having a dilating end, which reacts on an index affixed to a dial-plate near the handle. The end having been passed through the stricture, it is made to expand, and as the instrument is slowly withdrawn, the constriction is registered. A second or third stricture is discovered, in like manner, by continuing the urethral examination with the catheter, or by means of the urethrometer, if the latter instrument be deemed necessary.

To complete the examination of any one or more strictures, several instruments, of different sizes, will perhaps be necessary. In the English scale of 12, the five sizes from 7 downwards, will generally be found most serviceable, for this purpose. The French scale possesses three advantages over the English scale; it commences with a smaller size,—1 millimètre, or $\frac{1}{3}$ inch instead of 5 millimètres, and ascends by a series of smaller intervals between each number; the intervals are more regular; and the number of the catheter represents the calibre or size of the instrument,—No. 1 being 1 millimètre, No. 2 is 2 millimètres, and thence, by similar gradations, up to 30 millimètres. Nos. 3 to 21 about equal Nos. 1 to 12 English scale. No. 7, or 8 (English) size should always be tried first; a smaller-sized instrument is liable to hitch in one of the urethral lacunæ, or against the veru montanum, or in the sinus pocularis, as if it were fixed in the stricture; or it might pass through the stricture imperceptibly. Either occurrence would mislead the Surgeon. The smaller the instrument, the greater caution and delicacy must be observed in using it; lest incautiously the urethra be perforated. A soft *wax*-bougie has been recommended with the view of taking an impression or mould of the size and extent of the stricture. Any such supposed advantage is more than neutralized by the difficulty of finding the stricture, as compared with the facility in using an inflexible instrument.

The introduction of *bougies* and *sounds*—which are now much employed—require no special directions for their use.

Causes.—Two classes of causes may be recognised as resulting in the formation of an organic stricture.

(1) Inflammation of the urethra with *plastic deposit* in the mucous and sub-mucous tissues; thereby glueing together the organic muscular layer which immediately underlies the mucous membrane, and in virtue of which the canal naturally undergoes temporary alterations of calibre, by relaxation or contraction. This kind of cause comprises gonorrhœa; when the inflammation extends along the canal, and is of a severe or long-continued character. The symptoms of stricture supervene very slowly and insidiously; a period of many years perhaps elapsing before the existence of this organic constriction is declared. Simple urethritis may have the same result, but only under the operation of some persistent constitutional condition. Injections for the cure of gonorrhœa tend to the formation of stricture; when used in the inflammatory stage, or of too great strength, or long continued. Thus, an injection of nitrate of silver, j to ij grs. to ℥j of water, can do no harm; but in the proportion of x grs. to ℥j, it may certainly produce stricture. Abscess in a lacuna of the urethra followed by contraction of the *cicatrix*, is an occasional cause; and cancerous or other ulcers may similarly result in the formation of stricture, usually near the external meatus; amputation of the penis sometimes issues in like manner.

(2) Injury to the urethra by external violence on the perineum, bruising, lacerating, or rupturing the urethra,

is followed by a *cicatrix,* the contraction of which is very apt to result in stricture of the most severe and intractable character. This kind of cause comprises: kicks on the perineum, or falls on some hard projection, as across spars, scaffolding, ladders, chairs, saddles, gates, wheels, etc.; puncture of the perineum, by palisading, by an earthenware vessel breaking under the sitter, etc.; laceration, by pelvic fractures involving the urethra; and lastly, by the forcible introduction of urethral instruments.

The *age* at which stricture of the urethra usually occurs, corresponds, of course, with the period when its causes are most frequent. Gonorrhœal stricture, therefore, is most common from early manhood to middle age; but traumatic stricture may be produced more probably at any period of life.

Congenital stricture is occasionally met with, near the external meatus. In early life, its existence is unattended by any inconvenience; but in adult life, it gives rise to serious obstruction to the passage of urine, when the urethral tissue has become less extensible.

Consequences and *Terminations.*—The course of stricture is very similar to that of chronic enlargement of the prostate. *Retention* of urine gradually results from the diminished calibre of the urethral canal, at the seat of stricture. *Chronic* cystitis or a state of the bladder bordering on it, commonly ensues from the habitual retention of urine and distension of the bladder. The characters of the *urine* are in accordance with that condition. The *general health gradually declines;* as the result of broken rest from ineffectually relieving the bladder, and of constitutional disturbance owing to the state of the organ, aggravated by occasional attacks of *spasmodic retention;* or the constitutional symptoms may be those of increasing *nervous prostration* with oft-repeated *rigors,* induced sometimes by each act of micturition, or simply by the use of an instrument; and *rapid depression* may supervene, either from ulceration or sloughing of the bladder with recurring hæmorrhage, or from profuse purulent discharge.

Urinary *abscess* is apt to form, from the irritation of urine in the adjoining dilated portion of the urethra, immediately behind the stricture; and by opening into the canal and externally, urinary *fistula* is established. Urinary abscess is often preceded by increased thickening and induration of the urethra at the seat of stricture; possibly owing to a slight leakage of urine from behind that part, through a long and narrow sinus into the gristly swelling — a case of this kind having been demonstrated on dissection, by Sir B. Brodie. The symptoms of urinary abscess—usually in the perineum—are notable. Unusual difficulty is experienced in micturition, and increased retention of urine, therefore, distresses the patient. Some fulness may be felt behind the scrotum, and the part is tender; it becomes œdematous, and the scrotum may be somewhat involved. On deeper examination with the finger, induration is perceptible; this advancing to the surface, fluctuation can at length be detected, and the integument is overspread with a diffuse redness. The abscess bursts, or is opened, and discharges an offensive mixture of pus, urine, and slough. In time, contraction taking place, a fistulous passage remains, which presents a pouting, granular orifice; and posteriorly, the abscess communicates directly with the urethra. During the course of urinary abscess, the constitutional symptoms undergo significant changes. When forming, the abscess is attended, perhaps, with some shivering, and then with the usual febrility of deep-seated suppuration; varied only in degree by the age, and pre-existing state of the patient from stricture. But, when the abscess communicates with the urethra, the previously more or less sthenic symptoms of a full, hard pulse, and hot skin, with sleepless excitement, are exchanged for typhoidal depression, a weak, rapid, and perhaps irregular pulse, while the tongue becomes dry and encrusted with a brown fur. As soon as the abscess opens, all these symptoms are relieved, and any previous retention of urine ceases.

Rupture of the urethra is liable to occur, also, from dilatation of the canal, immediately behind a stricture; followed by *extravasation of urine,* with its attendant symptoms. This may happen at a more or less remote period. I have known extravasation occur in traumatic stricture, twenty-six years after the injury, a fall on the perineum across a beam; and also in stricture from gonorrhœa, five years previously. Rupture of the *bladder* is a very rare event; the urine then escaping into the peri-vesical cellular texture or into the peritoneal cavity, according to the situation of the rent. Both these consequences of Stricture are dependent on Retention of Urine, and they will be noticed under the head of Extravasation of Urine. *Suppression of urine,* with uræmia, sometimes arises from slight urethral irritation; as by the introduction of an instrument only one size, or number, larger than that to which the patientis accustomed, or in consequence of a slight urethral abrasion, or from the mere passage of an instrument. Severe rigors and suppression of urine are both far more apt to occur when disease of the kidneys exists, so that the one becomes a tolerably sure indication of the other; and the fatal issue is more rapid and inevitable.

Certain *pathological conditions* of the urethra, prostate, vesiculæ seminales, bladder, ureters, and kidneys, result from the mechanical effect of long-continued retention of urine. They are discovered, mostly, *after* death. The *urethra* is contracted in calibre before, and dilated sometimes into a sacculus just behind, the seat of stricture. In the latter, or dilated pouch, sabulous matter and even calcareous concretions occasionally collect. Rupture of the urethra may have taken place in this dilated portion; and in connexion with an abscess, usually perineal. This abscess may have opened externally, as well as communicate with the urethra,—constituting a fistula in perineo, with perhaps several branch fistulous openings and surrounding consolidation. The ejaculatory ducts also, in the sinus pocularis, are enlarged. The *prostate* gland has been found converted into an abscess, multilocular, or as a single cavity, bounded by the fibrous capsule; and communicating by one or more ulcerated openings with the prostatic urethra. The *vesiculæ seminales* are then often distended with glairy and fetid purulent matter. The *bladder*, which, in an early stage of stricture, is contracted and of diminished capacity, owing to the frequency of micturition, is subjected to the constant backward pressure of urine, which in time enlarges its cavity; it also becomes fasciculated internally, and perhaps sacculated; the one alteration of this organ representing an hypertrophied state of its muscular bands,

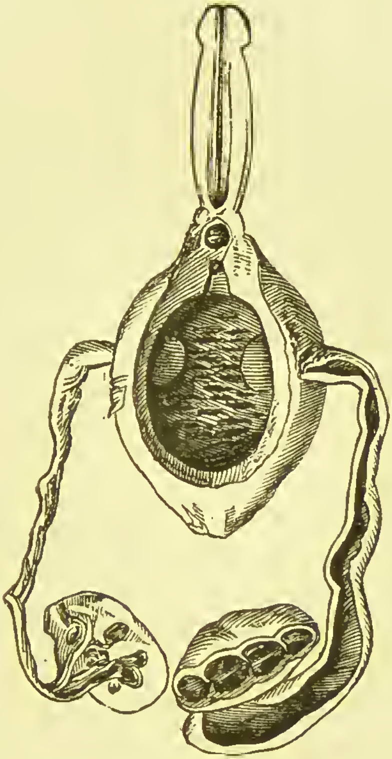

FIG. 46.—Roy. Coll. Surg. Mus., 2,540. Close annular stricture at the anterior part of the membranous urethra. Immediately in front is a small, round, and deep depression, produced probably by the points of instruments passed down to the stricture; just behind is a dilated sacculus, containing a small, imbedded calculus. The walls of the bladder are much thickened, from hypertrophy of its muscular coat, and thickening of the mucous membrane, which is partly covered with lymph, from acute cystitis; the ureters and pelves of the kidneys are much dilated,—the mid-portion of the left ureter being, however, almost closed; and the substance of both kidneys is atrophied and sacculated. The prostate gland is healthy. In this case, the patient was only thirty-six years old, of very intemperate habits, and had suffered from stricture for six or seven years. (T. G. Crosse.)

the other, intervening pouch-like protrusions of the mucous membrane. The general result is a diminution in the capacity of the bladder for the retention of urine (Fig. 46), or, its total capacity may be thus much increased. Rupture of this organ may have happened, though very rarely. Sometimes, it takes place in consequence of a small pin-hole aperture of ulceration in the mucous membrane of one of the sacculi. Not unfrequently, the bladder bears evidence of acute inflammation, or more commonly of chronic cystitis having supervened from constant retention of urine. Abscesses may perhaps form in the walls of the bladder, probably as the result of ulcerations of the mucous membrane; the matter finding its way in the peri-vesical cellular texture, may point in various distant directions, as in the groin or above the pubes. The *ureters* have undergone dilatation by the tendency to reflux of urine, and the pelvis of these tubes may thus be found much enlarged; while the *kidneys* are more or less degenerated and atrophied in their pyramidal and cortical portions, resulting perhaps in sacculated remnant kidneys, or in the formation of mere bags, or cysts. Sometimes these organs are beset with multiple abscesses, as the result of pyelitis or nephritis from the backward irritation of prolonged retention. Hence, the suppression of urinary secretion, with uræmic blood-poisoning. The various forms of kidney-disease which are thus consequent on chronic retention of urine, and which give rise to uræmia, have received the name of "surgical kidney;" a very inapt appellation, as if indicating the result of surgical interference, which would, however, have prevented the supervention of these renal conditions.

Treatment.—The object of treatment is twofold: to restore the urethral canal to its natural calibre, and to maintain that state of patency. But for the accomplishment of this object, different modes of treatment are necessary according to the various states of stricture: its degree of contraction, and induration or dilatability; its sensitiveness and proneness to disturbance of the nervous system; its contractility and disposition to return. All the modes of treatment may be reduced to four: (1) Gradual Mechanical Dilatation; (2) Immediate and Forcible Dilatation, or Rupture; (3) Caustics; (4) Division of the Stricture, either by internal urethrotomy, or by external urethrotomy,—usually perineal section.

GRADUAL MECHANICAL DILATATION,—inducing absorption of the plastic deposit around the seat of stricture. This method of treatment is most generally applicable; the other methods being resorted to when it proves ineffective, or when it is contra-indicated by one of the adverse states of stricture above mentioned.

The *instruments* commonly used for gradual dilatation are bougies and catheters,—inflexible, or flexible and elastic; and always of gradually increasing size. Sounds are more serviceable to maintain dilatation; and especially in irritable, or in resilient strictures.

The selection of an appropriate instrument, in respect to its material, terminal shape, size, and curve—if an inflexible instrument—will depend on the degree of contraction and the situation of the stricture; both these points have been determined by urethral exploration with a catheter, or bougie, as already explained in completing the diagnosis of stricture. A *catheter* is generally preferable for *that* purpose; as not unfrequently the patient first seeks relief when suffering from an attack of retention, and the Surgeon having succeeded in getting an instrument into the bladder, may be very glad to leave it there. Hence, also, a catheter is generally most suitable in the *commencement* of treatment.

The introduction of a *catheter* may be performed in either of the two ways already described, and according to the directions given. An instrument of such *size* only should be used as shall be found to enter the stricture easily, and can pass fairly through it without feeling tightly held by the contraction. Dilatation is then effected by leaving the instrument in this contracted portion of the canal; so as to continue the slight expansion, and induce absorption of the plastic deposit in the mucous and submucous tissues forming the stricture. The proper *period* for maintaining the dilatation is, in my judgment, about five minutes,—some say twenty minutes; then the instrument should be withdrawn, and its size, or number, noted, as a standard of comparison in the subsequent introduction of gradually larger-sized instruments. Professor Spence's three recommendations are, I am sure, here advisable:—always pass the size of instrument used on the previous occasion, before proceeding to the next larger size; never omit any one size to pass a higher one; never pass two larger sizes on the same occasion. By disregarding either of the two latter rules, undue irritation will almost certainly be excited, and the Surgeon is more likely to lose than gain ground. An instrument may be *reintroduced* every two or three days. But the intervals of catheterization must be regulated by the state of the urethra, and the constitutional disturbance induced. When bleeding, pain or smarting in micturition, follow or continue after the operation—events very likely to happen after the first passage of an instrument through the stricture—further dilatation must be postponed for a day or two, until this urethral condition has subsided. Rigor or shivering, faintness or sickness, may also supervene, especially under similar circumstances; postponing any reintroduction of an instrument until this state of constitutional disturbance has passed off. Chloroform, therefore, often becomes an invaluable agent in the treatment of tight stricture by dilatation. Spence is inclined to believe that rigor arises from the irritation produced by the instrument in passing over the prostatic urethra and neck of the bladder; hence, in using the smaller-sized instruments, when the flow of urine shows that the bladder is entered, the catheter should be withdrawn, and left only in the stricture; or in using those of larger size, the instrument is passed only through the stricture, and no farther.

Flexible and *Elastic Bougies* are now much employed as a substitute for catheters,—metallic or gum-elastic, in the treatment of stricture by dilatation, as well as in the diagnosis of stricture. These instruments owe their advantage not only to their flexible and elastic character, but also to the peculiar shapes of their distal extremities The forms more commonly employed are :—the *bougie olivaire* having an olive-bulb end, whereby the instrument can be insinuated or twirled into a stricture, aided by the flexible nature of the shaft, without the liability of making a false passage; the *bougie conique*, having a conical tapering point, can enter a stricture more readily, or even of tighter contraction, but it is liable to lodge in a lacuna, and make a false passage, which is prevented by the olive; the *bougie olivaire à ventre*, having a spindle-shaped enlargement above the olive end, thus specially dilates the stricture, and up to the largest-sized catheter, without painfully distending the comparatively narrow external meatus of the urethra; the *bougie conique à ventre* is similar to the last, and used for a similar purpose, but its conical end has some disadvantage relative to the formation of false passage; the *bougie à trois nœuds*, having three conical enlargements, of successively increasing size, this instrument is specially suitable for rapid dilatation.

For *very tight* strictures, the *filiform elastic* bougie may be twisted with an onward movement through the urethra, inch by inch from the glans, any obstruction being indicated by the shaft of the bougie springing back, when it should be withdrawn a little, and rotated onwards again, until it is arrested and held in the stricture. The *olivary whalebone* bougie, though almost filiform, is much stiffer, yet being provided with an olive end is safe in its passage; this instrument thus seems specially suited for very tight, indurated, and perhaps extensive stricture, as when of traumatic origin. The previous injection of the urethra with warm oil, to distend the passage, will much facilitate the transit of any filiform bougie through a tight and tortuous stricture. Elastic instruments were originally introduced into surgery by Bernard, a French goldsmith, who brought them before the Academy in 1779. Recently they have come into general use in America; and in this country, principally by the advocacy of Mr. Teevan. Probe-pointed steel sounds are also specially fitted for the dilatation of tight strictures; and I nearly always use these instruments in this class of cases. But if the Surgeon have not at hand any such instruments, or is more accustomed to the ordinary catheter—metallic or elastic, with rounded ends, a tight stricture may even then be overcome by pressure, judiciously moderated, and applied for several minutes, or a longer period than if the stricture were spasmodic. Sometimes, however, a permanent or organic stricture is very sensitive and contractile; but the pain will subside, and the obstruction yield under gradually increased pressure. And the attempt may have to be repeated every three or four days—as soon as the urethra has got quiet, until the stricture is entirely penetrated through.

This plan of treatment—by gradual dilatation, must be prolonged until the urethral canal is restored to its natural size, and the stream of urine fully established. The urethra may then admit a catheter of full size,—No. 12—or a bougie of equal size, with ease; when it should be passed less frequently, once in a week or ten days. Lastly, it will be necessary to maintain the patency of the canal, by an occasional use of the instrument once in a month or six weeks.

In the course of treatment by dilatation, the general health should be attended to; especially with regard to the digestive organs, and the state of the skin and kidneys.

Continuous dilatation may be advantageously resorted to when the stricture proves *obstinate* under the ordinary plan of gradual dilatation. Indurated stricture, therefore, may be thus treated; or an irregular stricture, complicated perhaps with false passage, which may render the repeated introduction of an instrument difficult. Sir B. Brodie also alleges that continuous dilatation is far less likely to induce rigors—the urine escaping through the catheter, and not passing over the surface of the dilated stricture. And, in all cases, this method is far more expeditious, where time is of consequence—for as much can thus be effected in two weeks as in two months by more gradual dilatation. The principle is that of rapid dilatation and dissolution of the stricture, by retaining the instrument in the contracted portion of the canal for a period varying from forty-eight to seventy-two hours, at a time. The catheter is fastened by means of tapes passed through the eyes of the instrument, on either side, and thence under the buttocks and over the thighs to a waist-band. If a gum-catheter be used, it can be secured by a strip of adhesive plaster to the penis. A peg of wood or bit of cork is inserted into the orifice of the catheter, and the water drawn off as occasion requires.

In the management of this process, three points must be observed:—the catheter should occupy the stricture, without fitting tightly or being grasped by it; the instrument, when tied in, should not project against the interior of the bladder; and after using a silver instrument on the first occasion, the succeeding instrument may be gum-elastic, as causing less irritation.

When, in about forty-eight hours, the catheter has become loosened in the stricture, and a slight purulent discharge has taken place around the instrument, it should be withdrawn. In two or three days, this procedure is renewed, and an instrument larger by two or three sizes may be at once introduced; and so on until a full-sized one can be passed easily. Recontraction must then be prevented by occasionally passing an instrument, at gradually increasing intervals of time.

Difficulties and Accidents in Catheterism.—Induration or hardening of the stricture sometimes presents considerable difficulty to insertion of the point of the instrument. This may perhaps be overcome by using a conical-shape pointed catheter, or bougie. But, if the stricture be not very sensitive, continued pressure on the face of the induration will probably cause the stricture to yield. Injecting the urethra with four or five drachms of olive oil seems to exercise an hydraulic pressure on the stricture by penetration of the fluid into the narrowed passage. *Spasmodic* action must be overcome by the means appropriate for spasmodic stricture.

False Passage.—A false passage, or a passage leading out of the natural urethral canal, is made by forcible and misdirected pressure with the point of any instrument in its course through the urethra. The passage, therefore, usually takes a direction downwards and backwards, and to one side of the urethral passage; in an opposite direction to the stream of urine, the free discharge of which remains unaffected. An inflexible instrument, as the ordinary silver catheter, will be more apt to cause this misadventure than a flexible instrument; but the latter is more liable to enter a false passage already existing.

The previous existence of such a passage or passages is perhaps the most common and perplexing occasion of difficulty in using an instrument; and its production, an accident most to be avoided. The importance of these considerations in relation to catheterism, lies in the fact that the difficulty of entering the right opening, is increased by the facility with which the instrument slips into the wrong one.

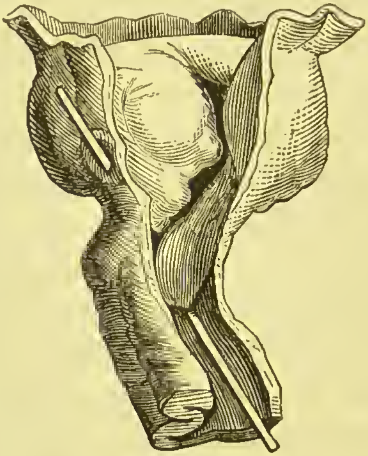

FIG. 47.—Roy. Coll. Surg. Mus., 2,508. (Liston.)

A false passage varies in its *situation* and *extent.* When the stricture is far forwards, the passage may run in the corpus spongiosum; when further backwards, in the usual situation, the passage may perforate either lateral lobe of the prostate (Fig. 47) or run up between it and the rectum (Fig. 48); this latter direction being especially dangerous. The *floor* of the urethra is most commonly the seat of a false passage; and it is most liable to happen in connection with a tight stricture, and the introduction of a small-sized instrument. Hence, in the treatment of such a stricture more particularly, and when it has been subjected to the previous use of instruments, an important practical injunction in passing the catheter is this,—the point of the instrument should be kept against the roof or *upper surface* of the urethral canal.

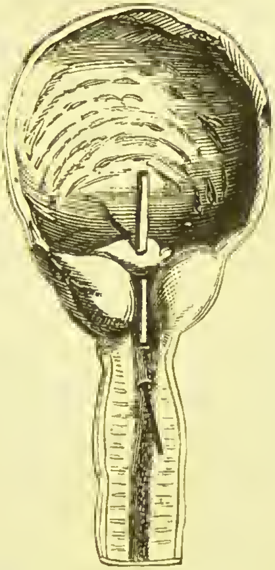

Fig. 48.—St. Mary's Hosp. Mus., H. *h*. 25. False passage, or tunnelling, through enlarged middle lobe of prostate, this passage commencing from the membranous urethra ; there is also another false passage almost opposite the bulb. (William Coulson.)

Certain *signs* at once indicate to the Surgeon that a false passage has been commenced, or entered, if preexisting. The point of the instrument is felt to make a sudden slip, and the shaft inclines to one side of the urethra ; the point also feels free and movable, and communicates a rough or grating sensation, while it can be easily withdrawn ; all these peculiarities being more notable when occurring after the instrument had been felt to be held or grasped by the stricture. The patient experiences sudden and severe pain, and is often conscious that something has given way; on withdrawing the instrument, it is found besmeared with blood, and there will be free hæmorrhage from the urethra, with perhaps, I have noticed, some degree of turgid priapism. But an *old* false passage, with consolidated walls, will communicate the same sensation as if the instrument were passing through a stricture, and is unattended with pain or hæmorrhage; the only obvious sign perhaps being some deviation from the natural direction in the course of the urethra.

To avoid accidentally dilating a false passage, instead of the urethra, it has been proposed to pre-occupy that passage with a fine probe-pointed whalebone bougie, before using the urethral bougie; a practice chiefly in vogue among continental Surgeons. One of the fine bougies is slid along the urethra, and if it slip into a false passage, it is left there; a second and a third such passage may perchance be pre-occupied in like manner; then, the urethral bougie can be thus guided almost with certainty into and through the stricture. This resource would seem to be appropriate only in the dilatation of a tight stricture, and when the false passages are not more in number than for the urethral canal to accommodate the fine bougies as well as the dilating instrument; and in thus taking possession of existing false passages, care must be taken not to make fresh ones!

Hæmorrhage must be regarded as another accident attending catheterism; but it is also liable to occur independently of any urethral lesion, from the mere passage of an instrument, in inflammatory stricture.

Inflammation affecting the urethra or testes may be induced by dilatation; especially with instruments of too large a size, or rapidly increased.

Other evil concomitants, or consequences, have already been alluded to; pain in micturition, rigors, faintness, sickness. These unpleasant symptoms usually pass off; but they may continue for some hours, or recur; until the patient, having had a succession of shivering-fits, dies suddenly from syncope, or succumbs from exhaustion. In an enfeebled and prematurely aged state of the constitution, especially if accompanied with kidney-disease, and a tendency to uræmia, rigors are more apt to occur. The symptoms then are always perilous, the patient sinking perhaps, and sometimes rapidly, from the supervention of coma. An attack of rigors should, therefore, be treated promptly, by measures to promote reaction. Hot brandy-and-water, or ammonia, having been given, and the haggard-looking sufferer lying wrapped in blankets, a sweat breaks out as the shivering abates; and the temperature, which had previously been high, now declines. Otherwise, the administration of stimulants should be reinforced by quinine and opium, which have a marked influence in controlling rigor and preventing its recurrence. Rigors are sometimes followed by constitutional disturbances which might least be anticipated. Sir B. Brodie mentions some such cases. The cold fit is succeeded by the hot fit, which subsides in a flooding perspiration; and the attack is over as usual. But continued fever may ensue and last for days or weeks. In another case, the patient became maniacal, and remained in that state for nearly a month. In a third case, the almost momentary introduction of a small elastic catheter having induced a severe rigor, this was followed by rheumatic fever, with inflammation of the muscles of the neck, from which the patient never entirely recovered.

Gradual dilatation having proved ineffective for the cure of stricture, other methods of treatment must be resorted to; and they are especially applicable, when either the *sensitive* state of the stricture or its *contractile* and recurring tendency would render that mode of treatment inapplicable, as being intolerable or unsuccessful. The degree of *tightness* of the stricture and the amount of *induration*, together representing an undilatable state of stricture, will be found to determine the particular mode of treatment then appropriate;—whether Forcible Dilatation or Rupture, or Division by incision, internally or externally.

Traumatic strictures especially represent the conditions for which these methods of treatment are generally requisite.

IMMEDIATE AND FORCIBLE DILATATION, OR RUPTURE.—In estimating the applicability, and advantage, of this method of treatment for stricture of the urethra, it would certainly appear that the vital character and constitutional relations of the urethral tube should forbid any dilatation of an immediate and forcible character; and still more so any rupture of its component tissues. Yet experience has now shown that not only may this mode of treatment be practised with impunity, but that a tight stricture undilatable gradually, beyond a certain degree, and any further distension of which would excite severe constitutional disturbance, can be forcibly dilated or ruptured up to the natural size of the urethra, and without producing any such symptoms.

Forcible dilatation is effected by means of *distending instruments*, which when passed through the stricture exert an expanding force from within outwards. Such force may be accomplished by a *series* of instruments, consisting of sliding-tubes, passed successively over a slender urethral director or guide, which is first passed through the stricture; or, it can be effected by means of a *single* instrument which expands *in sitû.*

Sliding-tubes were originally employed by Desault (1797), and afterwards by Dr. Buchanan of Glasgow (1831), Dr. Hutton of Dublin (1835), and by Maisonneuve (1845). Mr. Thomas Wakley, of the Royal Free Hospital, with whom this mode of treatment was originally identified in this country, contrived a series of accurately-fitting tubes and an urethral director. This having been first passed through the stricture, each sliding-tube, in succession, cannot fail to take the same course. The difficulty, and the risk, will always be to first introduce the slender director through a tight stricture; a difficulty proportionate to the degree of contraction, and the existence of false passages, or the liability of making them. *Single* instruments of various kinds have been devised, which expand *in sitû,* in the place of several instruments of increasing calibre; and thus save the necessity of passing them successively through the constricted part of the urethra. With this object, Mr. Luxmore (1812) employed diverging metal rods; Leroy d'Etiolles, the same method, some years later, and Perrève a somewhat similar plan (1847). Dr. Neil Arnott, on the same principle, commenced the employment of fluid expansion (1819). Both these forms of contrivance—the series of sliding-tubes and the single expanding instruments, have a similar action upon the urethra—distension of the contracted portion from *within* its area. They thus differ from the large conical metallic bougie formerly used for the purpose of forcible dilatation, which was driven into the stricture; thereby running the risk of pushing the stricture down the canal and detaching its connections, and inevitably inducing inflammation and severe constitutional disturbance.

Rupture or Splitting of the Urethra.—Mr. Holt has recently revived this mode of forcibly opening stricture of the urethra. It seems to be most applicable to tight stricture, *without* much induration; so that the plastic deposit does not form a mass too thick or dense to be entirely ruptured. Rupture may, therefore, possibly supersede the necessity for division by a cutting operation.

The "dilator" used by Mr. Holt is precisely similar to that of Perrève (Fig. 49). Its construction, and his mode of operating, he thus describes:—The instrument consists of two grooved blades fixed in a divided handle, and containing between them a wire welded to their united point; on this wire a tube—which when introduced between the blades corresponds to the natural calibre of the urethra—is quickly passed, and thus ruptures or splits the obstruction. Having introduced the instrument, and reached the bladder, it should be gently rotated, to prove that the end is fairly within that viscus; and being thus assured, the Surgeon is next to place the point of the tube he had previously selected, upon the wire between the blades, and thrust it quickly onwards to the end. The stricture being now fairly split, the dilator should be rotated, to still further separate the sides of the rent, and then be withdrawn; a catheter, corresponding to the number of the tube, being substituted for the purpose of removing the urine. The catheter is then withdrawn, the patient treated with quinine and opium for the first twenty-four hours; and the same catheter introduced occasionally perhaps during that period, to prevent any risk of urinary infiltration in micturition; or in forty-eight hours, to maintain dilatation; and again on alternate days for a week or two, gradually lengthening the interval. Voillemier's instrument differs from Holt's, in an important particular; the tube is provided with lateral grooves, so as to slide along the blades, instead of upon a central wire-conductor; the expanded instrument thus assumes a circular instead of an oval form, whereby the dilating force is expended *equally* upon the whole circumference of the urethral canal.

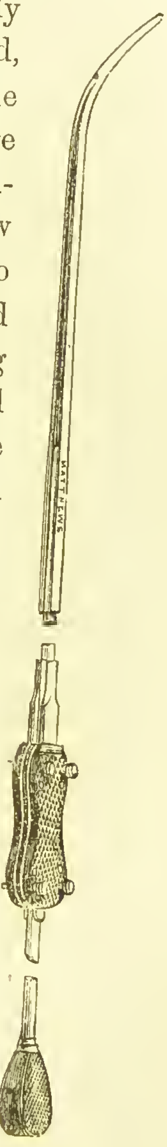

Fig. 49.

The *results* of this procedure in the hands of Mr. Holt have been eminently successful; and the experience of some other Surgeons has confirmed its value. I have not seen much constitutional disturbance follow the operation of splitting the urethra; but in one case, operated on in another Hospital, extravasation of urine ensued, for which I treated the patient at the Royal Free Hospital, and he recovered. Many deaths, however, have I believe occurred—Mr. Teevan says fifteen in number—which have not been included in the Reports of Cases hitherto published. It would also be very desirable to diagnose more correctly the *pathological conditions* of stricture submitted to operation,—if indeed they can always be determined clinically; since it will be obvious that the mere splitting up a number, say some scores, of urethræ, many of which were perhaps scarcely strictured at all, can have nothing to do with the propriety or eligibility of this mode of treatment. The splitting of urethræ in almost a *healthy* state, would necessarily swell the resultant proportion of, apparently, successful cases. I do not apply this remark to Mr. Holt's cases, but to an extraordinary large series which has been published.

Sir H. Thompson has contrived a screw-*distending* instrument for this operation, which seems to possess three advantages:—distension of the stricture *alone* is accomplished, without involving the healthy portion of the urethra in its action; the distension, as indicated by the scale near the handle, can be carried to a calibre of 14 or 16 of the catheter scale, beyond the size which the external meatus will admit, and is thus more efficient; and the distending force is applied very slowly, continuing from seven to ten minutes before reaching the maximum point of distension,—the object being to over-stretch the morbid tissues as much, and to rupture them as little, as possible, in order to destroy, or greatly impair, the natural tendency of the stricture to undergo contraction.

Another screw-distending instrument, devised by Dr. J. Thebaud, of New York, is worthy of notice. The terminal portion consists of two blades, which can be separated to such an extent as to rupture the stricture. Distension, or rupture, as thus effected, involves more than the constricted part of the canal,—a disadvantage compared with Thompson's instrument; while, relative to Holt's dilator, Thebaud's instrument has the disadvantage of being too large-pointed for tight strictures, but the special advantage of carrying distension to any known *degree* is supplied by the index near the handle.

Strictures of *very* tight character may be penetrated by a filiform bougie guide, adapted to the end of any such instruments; an addition originated by Van Buren, and completed by Charrière.

Caustics.—Cauterization, in the treatment of stricture, has been practised with two objects in view; the deadening of sensibility or spasm, and the destruction of induration; in both ways permitting subsequent recourse to dilatation. For the former purpose, cauterization may be of some use, and received the sanction of Sir B. Brodie's large experience. But he acknowledges the grave objections to this method of treatment—the liability to induce spasm, as well as to relieve it, to promote retention of urine, or to be followed by severe hæmorrhage, or rigors; and possibly to result in the formation of perineal abscesses and fistulæ. Hence, this practice was never resorted to in the first instance, and was reserved for only quite exceptional cases of stricture, complicated by spasm. Even then, if a false passage already existed, there would be the obvious risk of the dissolved caustic finding its way so as to produce great mischief.

As to the *destruction* of an indurated stricture by cauterization, such a result can only be produced by ulceration or sloughing; and this method of treatment is too little under the control of the Surgeon, and too perilous in itself, to be warrantable in the case of an urethral disease. But the possibility of stricture being removed by ulceration would appear from the history of a remarkable and probably *unique* case which occurred in the experience of the authority I have just referred to,—where an urethral stricture underwent apparently a spontaneous cure in this way. "A gentleman had laboured under a stricture of the urethra for a great many years. He voided his urine with the greatest difficulty, the stricture being very rigid and unyielding; but a catgut bougie was passed, and this enabled him to make water in a small stream. Under these circumstances he was seized with pain in the act of making water, which lasted for some minutes afterwards, being felt in the situation of the stricture in the posterior part of the urethra. The pain became more severe, and the patient described it to be intolerable, saying that he could compare it to nothing but the sensation which he supposed might be produced if melted lead were poured into the canal. Every half-hour he had a desire to make water, and his groans might be heard, not only through the whole house, but even in the street. In the course of a few days these symptoms began gradually to abate, and now it was discovered that the urine flowed in a much larger stream. When the attack had completely subsided the condition of the patient was much improved, and he made water more easily than he had done for many years."

Cauterization can be effected by the introduction of an instrument armed with caustic, such as nitrate of silver or potassa fusa, which is carried down to, and allowed to rest against, the stricture, for two or three minutes. The patient, who previously could only squeeze out urine in drops, may now be able to pass a full stream, the irritability of the stricture being exhausted, at least for a time. A gleety discharge is established, and the caustic may be reapplied every two or three days until a catheter or bougie can be passed, and gradual dilatation made to complete the cure.

This method of treatment was formerly in vogue, having been introduced by John Hunter, and recommended by Sir E. Home, in certain cases; it still, I believe, has one or two advocates in this country, principally the late Mr. Wade, and is less urged by Mr. H. Smith; but the experience of the best Surgeons both here and in France has condemned it, as being both perilous, and extremely uncertain in its results. Stigmatized by Mr. Liston as "most atrocious," and discountenanced more recently by Nélaton, the cure of stricture can always be accomplished more safely, and with greater probability of non-recurrence; not to mention the liability of making a false passage, and the other contingencies referred to. Perhaps some of the extreme differences of opinion which have been held respecting this practice may be reconciled by the degree to which it has been carried in the hands of different Surgeons. Brodie's more satisfactory experience may have been due to the more judicious moderation with which he used caustic in cases of stricture, attended with spasm or an irritable state of the urethra; for he expressly mentions that he limited the application to a quarter of a minute, and repeated it not more frequently than every third or fourth day,—the second day being much too often ("Works," 1865, vol. ii. p. 431). Cauterization has, however, now fallen into general disuse.

DIVISION OF THE STRICTURE.—Section of the urethra may be appropriately resorted to in tight stricture, with considerable induration, forming a hard and large *nodule*, unfitted for rupture; and accompanied perhaps with much sensitiveness and irritability, or contractility and resiliency,—conditions which are also unfitted for gradual dilatation. The incision is made either from within the urethra, or from without, and usually in the perineum.

(1) *Internal Urethrotomy.*—Division of the stricture from within the urethra has been practised for above a century. Allies of France (1755); Physick of Philadelphia (1795), John Bell (1806), and his brother Charles Bell (1807), M'Ghie (1823), and Stafford (1827), have severally advocated this method of treatment. It has been practised extensively in France, especially by

Civiale; and less frequently by modern Surgeons in America and in this country.

The operation may be performed in two ways:—*incision from before backwards,*—section being made by pushing downwards a lancet-like blade, generally with a slender conductor in advance of it, into the obstruction to be divided; *incision from behind forwards,*—a portion of the instrument containing a small blade, sheathed, is first carried down through the stricture, which is then divided by protruding the blade downwards and withdrawing it, in the floor of the urethra, through the whole of the contracted portion, with a little of the sound urethra in front and behind, but taking care not to incise too freely in depth. Thus, the length of this incision may be from one to two inches, while its depth should not exceed more than half that to which the blade can be projected in Civiale's instrument. The penis should be stretched to steady the otherwise movable urethra. Prior to operation, it is well to prepare the way for the introduction of an urethrotome through a tight stricture, by passing a catheter of moderate size, and leaving it in for sufficient time, according to the temper of the stricture, just to relax the grasp upon the instrument. Of the two methods of operation, the former is suitable for antibulbous strictures; the urethra being straight in that portion of its course, is not liable to perforation; deeper strictures, situated in the curve of the canal, had better be incised from behind forwards.

Various instruments, or *urethrotomes,* have been constructed for the internal division of strictured urethra.

For incision from before backwards, Stafford's lancet-catheter may be used; the point is concealed in the

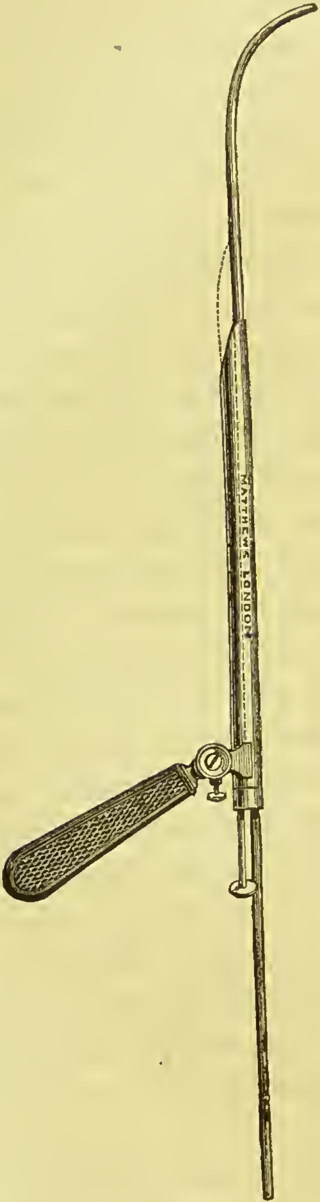

Fig. 50.

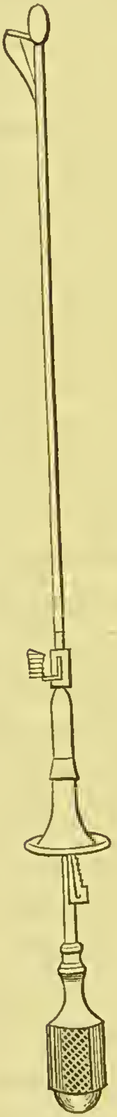

Fig. 51.

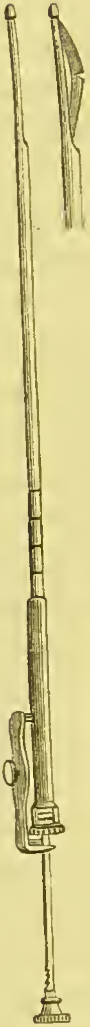

Fig. 52.

tube until the end of the instrument rests upon the stricture; it is then projected, and the instrument carried on through the obstruction. A curved, as well as the straight form of this instrument, has been employed. Sir H. Thompson's catheter-urethrotome, or Mr. John Wood's instrument (Fig. 50) is more applicable. For incision from behind forwards, Civiale's urethrotome is the best form of instrument (Fig. 51). Trélat's urethrotome (Fig. 52) can be used in both ways,—from before backwards, and then from behind forwards; thus making a second incision when necessary, and the operation more complete. After either mode of operation, a full-sized catheter should be introduced along the roof of the urethra to avoid the incision. If the instrument does not pass easily, but a hitch is felt, some fibres of the stricture have been left undivided, and must be severed by reintroducing the urethrotome. The catheter should be retained for twenty-four hours; although some Surgeons of experience think this practice unnecessary or objectionable. An instrument should also be passed occasionally, for some time, to prevent re-contraction. An urethrotome provided with a terminal filiform bougie, as devised by Maisonneuve (Fig. 53), or the similar shielded instrument of Voillemier, will enable the operator to deal with *very* tight strictures.

Dilating urethrotomes have been constructed to stretch, and then cut the dilated stricture. Instruments of this kind were introduced by Reybard originally, and since by Otis (Fig. 54), with graduated shaft, and register at the handle to indicate the degree of separation of the two parallel blades. Such an urethrotome is applicable for the division of resilient stricture, and stricture of *some size,* but which resists further dilatation, or rapidly recontracts. Constriction of the *meatus,* or within an inch of the urethral orifice, may be conveniently incised by Civiale's concealed bistoury.

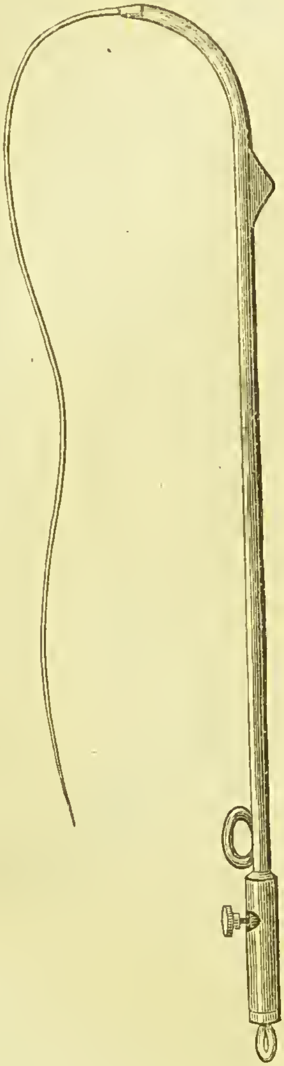

Fig. 53.

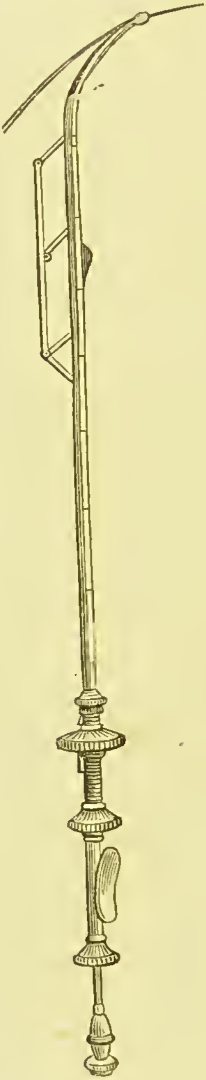

Fig. 54.

The immediate effects and after-consequences of internal urethrotomy are very seldom serious. Hæmorrhage, beyond a few drops of blood, is rare, and easily stopped by passing a full-sized instrument, and the application of ice externally. Some feverishness often ensues, but soon subsides. Abscess and extravasation of urine are very uncommon, having taken place once or twice only in nearly 300 cases operated on by Sir H. Thompson; while cystitis, nephritis, and pyæmia are unknown.

The *results* of internal urethrotomy are also satisfactory as regards the immediate restoration of the urethral canal to its natural calibre; the ultimate result may be permanent, or evince a tendency to the return of stricture,—generally, however, amenable to dilatation. But it should be observed that in both modes of internal urethrotomy, the strictured portion of the canal is usually already sufficiently large to admit an instrument, equal in size to a No. 4 or 5 catheter; and that with this degree of patency, it may well be considered probable that further and perhaps complete enlargement might be accomplished by dilatation. The exceptional cases are, nodular thickening and resiliency of the stricture, superadded to tightness. I very rarely find it necessary to have recourse to internal section of the urethra. But the operation is at least a safe procedure; only two deaths having occurred in the above series of 300 cases.

(2) *External Urethrotomy.*—Division of the stricture by external incision is an alternative operation of urethrotomy, the earliest instance of which for the cure

of stricture is recorded by Wiseman (1652). A few years afterwards, Solingen, at Livourne, adopted this procedure; followed by François Tolet and Colet (1690). J. A. Petit, and Ledran (1740), had recourse to a similar operation; and John Hunter (1783) performed the operation now known as the perineal section; but it was rarely employed until advocated by Mr. Grainger of Birmingham (1815), and afterwards by Mr. Arnott. These operations refer to cases in which no instrument could be passed through the stricture. More recently (1844), Mr. Syme has advocated external division of the stricture in cases where, although a catheter can be passed, no other treatment has afforded sufficient or permanent relief.

Perineal section, as the operation of external division of the stricture may be generally designated, is applicable in two degrees of extreme urethral contraction:—permeable stricture, through which a slender grooved staff can be passed, and the external incision made upon this instrument; and impermeable stricture, through which no instrument apparently can be passed, the only guide being a full-sized instrument passed down *to* the stricture, towards the point of which the external incision is directed.

The condition of stricture appropriate for perineal section, is that of considerable, even cartilaginous, induration, both in *thickness* and *extent*, appreciable usually by external examination with the finger; coupled perhaps with perineal fistulæ, either chronic or numerous.

(*a*) *Permeable Stricture.*—Perineal section, by Syme's operation, is performed as follows:—The instruments required are: a staff, slender, slightly curved, with a median groove in its lower half, and the upper of full size; a pointed scalpel; a broad director; and a silver catheter, No. 8, or 10. The staff is passed *through* the stricture, so that the shoulder or termination of the upper thick portion rests against the upper part or face of the stricture. The patient is tied up as for lithotomy, and the staff held in like manner by an assistant, with the scrotum drawn forwards. The Surgeon, sitting in front, makes an incision in the raphé or median line of the perineum, about two inches in extent, and proceeds cautiously straight to the shoulder of the staff; feeling his way with the forefinger of the left hand. Having clearly reached that point, he takes the staff from the assistant in his left hand, and enters the point of the knife in its groove, *behind* the stricture (Fig. 55); thence cutting upwards to the shoulder of the staff until it can be passed onwards into the bladder. This instrument is then

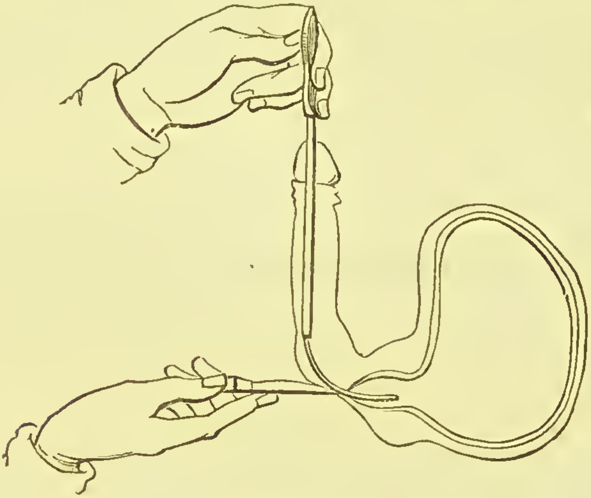

FIG. 55.

withdrawn, and the No. 8 catheter introduced and retained for forty-eight hours. The presence of a catheter has been condemned, as being possibly a source of irritation; but it preserves the full patency of the canal, as well as precluding the escape of urine, during the closure of the urethral incision. Subsequently a full-sized catheter should be passed every three or four days, and afterwards at longer intervals, to prevent recontraction—after the urethra has closed, and during granulation of the perineal wound. Difficulty in introducing the catheter after withdrawing the staff, may be overcome by first passing the director into the urethral wound, along which, as a guide, the catheter glides into the bladder. But Gouley's *catheter-staff* (Fig. 56) is especially adapted to obviate the difficulty which thus arises in the operation with Syme's staff. The former instrument being a catheter, is not withdrawn, and the groove on its convexity terminates in a loop, for the transmission of a filiform whalebone guide to the catheter, in passing through the stricture into the bladder. Instead of using a catheter, Mr. Syme preferred at first to pass a tube through the wound into the bladder, in order to guard

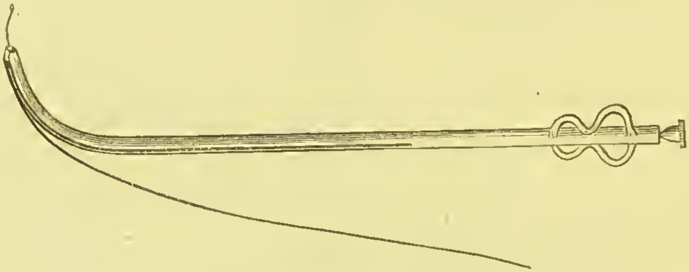

FIG. 56.

the wound as much as possible from contact with urine. The objection to this practice is, that it kept the urethral as well as the perineal wound open. Hæmorrhage rarely proves troublesome immediately after the operation, or subsequently; and it can be stopped by careful plugging of the wound, then placing a compress over it, and retaining the whole in position by a T bandage—a catheter being kept in the bladder.

The following directions are given by Mr. Syme as essential to the success of this operation:—1. Maintain the median line in the incisions. 2. Make a direct opening down to the staff, not a tortuous one. 3. Divide the whole of the contracted part, rather more than less. 4. Do not cut so far back as to endanger the deep fascia of the perineum, and use the knife in the deep incisions with the cutting-edge uppermost. 5. Do not close the end of the inlying catheter, lest urine be forced into or through the wound, for want of patency in the instrument. 6. Avoid escape or displacement of the instrument. 7. If incisions are made far back, introduce a curved tube through the wound when the catheter is withdrawn. 8. Do not neglect dilatation during the progress of recovery.

(*b*) *Impermeable Stricture.*—This condition of stricture is very rare, if it ever exists. As Syme justly observes, any stricture through which urine can escape, will admit an instrument to be passed with care and patience. Then, of course, the operation may be performed as for permeable stricture. Otherwise, a catheter of full size, having been passed down *to* the stricture, and held there firmly by an assistant, perineal section is performed; the point of the instrument being the guide to, but not through the stricture. Having clearly reached that point, the Surgeon endeavours to pass a small grooved director through, or partly through, the stricture; and on this instrument he at once divides, or successively pursues the tract of the contracted canal. This latter mode of performing the operation has been overruled by the more recent use of filiform bougies; so that the term, impermeable, or impassable stricture, is almost equivalent to the Surgeon's acknowledgment of his inability to pass such an instrument. A filiform whalebone guide having been introduced through the stricture, the catheter-staff is passed over it down to the front of the stricture, and then the urethral incision may be readily and safely followed up along the black line until the catheter can be slid on into the bladder. When no director, however small, can be introduced, the urethral canal must be followed without any such guide, by dissection alone, cautiously conducted. Sometimes the dilated portion of the urethra—behind the stricture, may be punctured, and a director passed up to meet the point of the knife, coming downwards, from the end of the catheter-staff, in front of the stricture; or the knife may be at once carried forward, with the director, from behind the stricture, to the end of that instrument. The urethral dilatation may perhaps be reached by following up the opening of a perineal fistula, when situated near the middle line. Such has been my experience of the various resources which I have found advantageous, under different circumstances, in the operation of perineal section. In any case, as soon as the continuity of the passage is restored, the catheter above is to be carried on into the bladder, and retained in the usual manner for a period of some days.

To meet the difficulty of hitting the point of the staff in front of the stricture, Mr. Wheelhouse, of Leeds, performs the operation of perineal section with a straight grooved staff or director, having a slightly *hooked* extremity, the groove terminating within a quarter of an inch of the extremity. This instrument is passed down until the end rests lightly against the stricture. A median perineal incision is made, reaching the urethra only a quarter of an inch above the end of the director, and, therefore, falling into the groove without exposing the hooked end, which is then turned round to the front, made to hook up the upper angle of the wound, and held steadily in position by an assistant. Two other assistants retract the sides of the wound, so as to expose the urethra where the anterior part or face of the stricture must be situated. By searching with a probe, this spot will now be found and opened, and the director carried thence through the stricture, which is then divided in its whole extent. A catheter is introduced into the bladder, and tied in for a few days.—*British Medical Journal,* June 24th, 1876.

It is important that the Surgeon should thus follow the operation of perineal section with different instruments, especially as regards the more difficult, although exceptional condition of a so-called impermeable stricture, in order that if he have not one instrument at hand, he may be able to accomplish the operation with another.

Results of Perineal Section.—The operation of external incision without an urethral guide, is of course hazardous and uncertain in its results. But external incision, as performed on a grooved staff, has yielded excellent results—in an appropriate condition of stricture, and when the operation has been properly performed. Among 219 cases of this operation, collected with scrupulous care by Sir H. Thompson, there was a mortality of between 6 and 7 per cent. Of this percentage, nearly two-thirds died of pyæmia, the remainder, one or two only excepted, from fever and suppression of urine. Such a mortality is not large, considering the extreme cases of stricture and broken constitutions subjected to the operation. Neither hæmorrhage, nor urinary infiltration, rank as causes of death from perineal section. But the stricture almost always returns, unless catheterism or the passage of bougies be practised occasionally, for some time after recovery from operation.

The *pathological conditions* of stricture submitted to operation, will of course materially affect the proportionate result of apparently successful cases. Perineal section is appropriate for the condition—originally proposed—an almost impermeable stricture, and which is otherwise incurable by dilatation—and this is always implied, when *properly* speaking of the operation and its results; but I have seen perineal section performed when, at the time of operation, a full-sized catheter had just before been passed, easily, into the bladder—and the operation having been performed simply for extravasation of urine.

Complications of Stricture. — In connection with urethral stricture, various complications may be met with; mostly occurring in the course of the disease—as the *consequences* of stricture. They comprise: *retention* of urine; *cystitis; urinary abscess; rupture* of the *urethra,* or *bladder,* with *extravasation of urine; suppression* of urine with uræmia. But as depending also on various other causes, these complications are noticed under their respective headings. *False passage,* and *rigors,* may happen in connection with the *treatment* of stricture.

Spasmodic Stricture.—This kind of stricture is due to the spasmodic action of the muscle surrounding the urethra, and is of a temporary character. It rarely occurs alone, but usually as a supervention on organic stricture, or in connection with an inflamed state of the urethral canal. Spasmodic stricture may occur at any portion of the urethra, by contraction of the layer of involuntary muscular fibres which encircle it throughout its course; or the membranous portion of the urethra may be constricted by spasm of the compressor urethræ muscle, acting as a sphincter on this portion of the passage, and this is the usual seat of a spasmodic stricture of the urethra.

The symptoms are those of obstruction to the passage of the stream of urine, but of temporary duration although perhaps oft-recurring. They thus differ from the same symptoms in organic or permanent stricture.

Local and urethral conditions, or remote and constitutional conditions, may severally give rise to spasmodic stricture. The first class comprises, principally: the presence of organic stricture; of inflammation from suppressed gonorrhœal discharge; irritation of the urethral mucous membrane from various states of the urine, especially a highly acid state—in various constitutional conditions, as gout; foreign matters ingested, and expelled by the urine, as cantharides, turpentine, condiments, alcoholic drinks; and the voluntary retention of urine for too long a time, or a stone in the bladder. The second class of causes comprises chiefly: rectal irritation, as from hæmorrhoids, fissure, prolapsus, fistulæ, operations on the rectum, ascarides, and anal prurigo; derangements of the digestive organs, and of the cerebro-spinal system. The *social* circumstances under which the practitioner will commonly meet with spasmodic stricture are characteristic. As affecting the more affluent classes of society; the indulgence over-night of acid wines, punch, or stimulating food and condiments, at supper-parties or convivial meetings, may be followed next morning by an attack of spasmodic stricture, especially in persons of a gouty diathesis. The restraints of society with regard to the retention of urine, the outdoor amusements of hunting, steeplechasing, or other rough-riding across country, are also circumstances under which spasmodic stricture is liable to occur. Or the picture may be reversed; the combined effects of cold and exhaustion drives many a homeless wanderer to seek relief at any hospital during the early hours of our winter mornings. The anxiety and harass of business, the pressure of over-study, or of writing against time in newspaper offices, etc., not unfrequently subject the commercial and the literary classes of society to the penalty of an attack of urethral spasm.

Treatment.—The cause of spasm must be sought, and if possible removed. In an attack of spasmodic stricture, remedial measures should be directed to the relaxation of the muscular contraction. The most effectual antispasmodics are a warm bath, and a full dose of opium—the tincture or Battley's sedative. I have used a drachm or more of the compound tincture of camphor with advantage. Chloroform inhaled has sometimes afforded instant relief. Suppositories have not had much effect. This antispasmodic treatment is most successful when the stricture arises from exposure to cold. But, if the gouty diathesis prevails, or the circumstances of origin point to acidity of urine; then alkalies and other appropriate remedies must be combined. Catheterism should be avoided as long as possible, the introduction of an instrument tending to provoke spasm; and when resorted to, the catheter used should be full-sized, or at least one of the higher numbers. But the instrument must be introduced with even more than usual light-handedness; and when the obstruction is reached—judging that the point of the instrument is in the right direction, pressure against the stricture continued for two or three minutes or longer, will probably exhaust the urethral irritability, and relax the spasm, so as to allow the catheter to proceed onwards into the bladder. If, however, the point of the instrument can be only insinuated into the entrance of the stricture, it will probably induce a violent effort to pass water, which dilates the passage from above; and then immediately withdrawing the catheter, the urine will follow in a tolerably full stream. I first learnt the value of this manœuvre, from a trick which a patient told me he had long practised upon himself. He was a very hard drinker; taking as much as forty glasses of whisky a day. He often was attacked with spasmodic retention, and was accustomed to relieve himself by the rough and ready method of thrusting a piece of stick—for a bougie—up the urethra, just to "uncork" the stricture.

Inflammatory Stricture.—An inflamed or congested state of the urethral mucous membrance may occasion a species of temporary stricture. It is less an independent condition, than engrafted on a pre-existing organic stricture, or coincident with spasm.

The symptoms are somewhat peculiar. In addition to obstructed micturition, the penis is turgid and erectile, and the urethra bleeds freely on the introduction of even a moderate-sized catheter; there is intense scalding in passing urine, and the stream narrows rapidly during the act, ceasing abruptly before the bladder is emptied. The urine is, as it were, shot out at short intervals from the bladder itself in an irritable state. Perineal heat, fulness, and tenderness are complained of, when the inflammation extends far back. In all these respects inflammatory stricture contrasts with that produced by spasm.

As causes of this kind of stricture, may be mentioned, retrocedent gonorrhœa, or suppression of the discharge by exposure to cold or wet, or by an inconsiderate recourse to injections during the inflammatory stage. Indulgence in alcoholic liquors or a stimulating diet, will also contribute to the inflammatory or congested state of the urethra.

Treatment must be conducted on ordinary principles. This urethral condition resulting usually from suppressed gonorrhœa, it will subside on the reappearance of the discharge. Wrapping the penis in a poultice is a simple remedy which I have often found successful.

TUMOURS IN THE URETHRA.—Growths within the urethra, formerly known as "caruncles" or "carnosities," and supposed to be common, are extremely rare. Their nature, according to Sir. H. Thompson's careful examination of recorded cases, seems to be of three kinds:—vascular granulations, situated generally near the external meatus, or projecting; polypoid formations, peculiar to the prostatic part of the urethra; masses of tubercular and cancerous origin. Both the latter kinds of deposit are rarely primary in the urethra, but secondary to disease of the kidney, bladder, or prostate; and they seldom appear until the primary disease is far advanced. Either sex is liable to these tumours.

The *endoscope*, an instrument for inspecting the urethral canal, and the interior of the bladder, may afford some aid in detecting and diagnosing urethral formations. Originally suggested by the late Mr. Avery, the instruments devised by Desormeaux, Cruise of Dublin, and Wales of Philadelphia, are more or less useful; Wales' endoscope having the advantages of simplicity and cheapness.

The local importance of any such urethral tumour is the degree of obstruction thus offered to the free passage of urine, as a cause of retention.

Treatment.—Urethral growths may be removed on the same principles as similar tumours in other parts;—

by Excision, Ligature, Caustics, or the Actual Cautery. Excision can generally be accomplished by means of scissors, aided by dilatation of the urethra. In this way I have succeeded, especially as regards the female urethra, in removing vascular and erectile growths, which although not of large size were very troublesome. Ligature is difficult, painful, and tedious; unless the growth be polypoid, when it may be looped with silver wire. Caustic applications, as nitric acid or potash, can scarcely be restricted in their action to the growth alone; and the actual cautery by means of the galvanic wire will be preferable.

CALCULUS IN THE URETHRA.—Urethral calculus is generally derived from the kidney and bladder, or from a fragment of stone becoming arrested in some part of the canal,—after lithotrity; but rarely, the calculus forms within the urethra, by deposit in the sacculus or dilatation behind a stricture. Here urine constantly collecting may give rise to concretion, or it forms around a particle of calculous matter as a nucleus.

The calculus is usually of the lithic acid variety; it more than occupies the calibre of the canal transversely, and assumes an elongated form; it may attain to a very large size. Several calculi are sometimes present; small, smooth, and faceted.

The symptoms are obvious—frequent and difficult micturition, bordering on retention; and the stone may be felt externally in the perineum or detected by introducing a sound, which at once strikes against the calculus, or grates roughly over it when embedded in a dilated portion of the urethra. Rectal exploration with the finger is often serviceable. Care must be taken, in either case, to guard the canal on the vesical side, with the finger, lest the stone be pushed back or might slip back in the bladder. Pain in the situation of the calculus is sometimes experienced, especially if the stone be rough, and movable in the act of micturition; but not unfrequently there is no such symptom, and the calculus lies singularly quiescent and unsuspected.

Ulceration and abscess are liable to ensue, resulting in extravasation of urine, and urinary fistula.

Treatment.—The calculus may perchance be expelled in the passage of a full stream of urine. Hence, the Surgeon sometimes avails himself of this natural mode of cure, by directing the patient to retain his water as long as possible, and then to compress the urethra with his fingers in front of the calculus when he endeavours to micturate; the stream of urine coming out suddenly with a forcible gush, carries before it the stone. The removal of an urethral calculus must, however, generally be effected either by extraction or by incision. When situated in *front* of the scrotum, the calculus can often be extracted, by passing down the urethra a long, slender, urethral forceps (Fig. 57), aided by moderate dilatation; or failing thus to remove the stone, it should be pushed

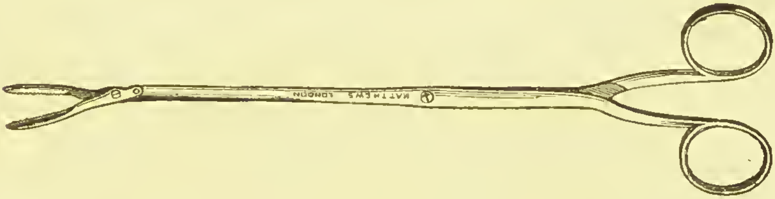

FIG. 57.

back into the perineum, and then removed by incision, any incision of the urethra in front of the scrotum generally resulting in a fistulous opening. A stone lodged in the navicular fossa near the meatus, may be eased out with a small scoop by dilatation, or by a slight incision of the orifice with a probe-pointed bistoury, which I disapprove of, as liable to induce stricture. When the calculus is situated in the *perineal* portion of the urethra, or has been pushed back to that part, it should be removed by a clean median incision on a grooved staff—external urethrotomy—at the same time compressing the urethra firmly with the finger behind the stone, lest it accidentally recede into the bladder. If this happens, a long pair of slender forceps can perhaps be introduced and the stone extracted. After the perineal section, there is little risk of urinary extravasation, and less of fistula or of stricture resulting.

In the *membranous* or *prostatic* portions of the urethra, an impacted calculus may admit of extraction by the median operation of lithotomy. Or the stone can be pushed back into the bladder, either by means of a large-sized catheter, or by urethral injection. It may then be removed by lithotrity or lateral lithotomy.

Foreign bodies of various kinds have been introduced into the urethra by persons to gratify some morbid curiosity or prurient feeling; and any such body having slipped out of reach, surgical assistance becomes necessary. Thus, a *hair-pin* has been passed into the urethra, and the ends expanding, and sticking in the mucous membrane, they cannot be secured with forceps. But, if the pin be compressed through the urethra with the thumb and finger, a small thin tube may be slid over the ends of the pin, which can then be extracted through the tube.

The *consequences* of a foreign body in the urethra may be the speedy supervention of inflammatory swelling, with retention of urine; or calculous encrustation takes place: often, however, the substance passing back into the bladder, it there forms the nucleus for stone. *Treatment* for the removal of any foreign body must be conducted as for urethral calculus.

In the *female,* the removal of an urethral calculus, or other impacted foreign body, can be accomplished by dilatation of the passage; or this procedure may be necessary to reach an urethral growth.

Retention of Urine.—This term is understood to signify an inability, arising from various causes, to pass any urine, or only a very small quantity. It thus differs from the partial retention of urine in engorgement of the bladder with occasional overflow, and which is dependent on enlargement of the prostate. Moreover, the one is a recent or acute condition, the other an habitual or chronic condition.

The symptoms are not only an absence of micturition, or the escape of urine by drops after much straining and painful effort; but also, as the bladder becomes distended and rises above the pubes, there is dulness on percussion over that region, extending upwards at length perhaps to the umbilicus. Pressure provokes a desire for micturition, unless the bladder has become insensitive. In the rectum, the base of the bladder can be felt with the finger to be distended, and supra-pubic palpation produces fluctuation. Some dribbling of urine from the urethra at length betokens extreme distension, but without affording any real relief. This condition is accompanied with much distress and constitutional disturbance.

Various causes may give rise to retention of urine, but they are all reducible to two classes :—(*a*) that of *defective expulsive power*,—from *atony* of the bladder, in *paralysis* involving the abdominal muscles and bladder, or from hysteria, shock, coma, concussion, or other cerebral conditions, typhus and other fevers; or (*b*) that of *obstruction* to the passage of urine, as dependent on *prostatic enlargement* from any cause,—inflammation, chronic hypertrophy, a tumour, or a calculus, of a sufficient size to block up the internal meatus of the urethra; a tumour, or a calculus, coagulated blood, thick mucus, or false membrane, within the bladder; *perineal abscess*, occasionally; *stricture of the urethra*, organic, spasmodic, or inflammatory; *urethral tumours, calculi*, or other foreign bodies in the urethra; peri-urethral deposit or tumour, and phimosis, occasionally. Pelvic tumours, *e.g.* a cyst between the rectum and the bladder, or a growth from the pelvic bone, are even more rare causes of obstruction. Pregnancy, uterine tumours, flexions and versions of the uterus, may also be mentioned; and impaction of the rectum with fæces or a foreign body is sometimes met with.

Unrelieved retention of urine leads generally to *rupture of the urethra*, and especially when the source of obstruction is in the urethra, the canal yielding behind that point, and this event being followed by extravasation of urine; rarely, *rupture of the bladder* occurs in consequence of retention.

Treatment.—Retention of urine must of course be regarded with reference to the removal of its cause; but the bladder admits of being entered, and the accumulated urine drawn off, in five different ways:—(1) by catheterism; (2) incision of the urethra through, or behind, the obstruction, usually in the perineum; (3) puncture of the bladder,—through the rectum; (4) above the pubes, or (5) through the symphysis pubis.

Catheterism.—This mode of gaining admission to the bladder will usually succeed; in conjunction with the appropriate treatment for any temporary spasmodic or inflammatory obstruction, which may have become engrafted on an *organic* stricture, from some excess or from exposure to wet or cold,—the circumstances under which retention generally arises. Accordingly, a small-sized catheter is selected, about No. 4 or smaller, silver or gum-elastic; and the instrument introduced with due attention to gentleness, caution and patience. The stricture may often yield more readily than might have been anticipated when retention is present, owing to the dilatation effected by the pressure of urine above; or the resistance may be overcome by pressing the point of the instrument steadily against the stricture, and more firmly than if the obstruction were simply spasmodic, when in the course of a few minutes the catheter will slowly glide into the bladder; or, when the instrument cannot be got further than just the entrance of the stricture, on withdrawing the point, the urine will often follow in a tolerably full stream.

Having passed the usual seat of stricture—at about the bulbous urethra, the instrument may be arrested; owing to the acute angle of the urethra behind the triangular ligament, as the distended bladder rises out of the pelvis. This impediment will be increased by enlargement of the prostate, especially of the middle lobe. A catheter of sharper curve must be used.

If the Surgeon fails in thus affording relief by catheterism, he should have recourse to relaxatives or local bloodletting, as the case may be. With *spasmodic* stricture: the patient should be placed in a warm bath, and opium given by the mouth, or in the form of enema or suppository, or chloroform administered; the latter agent being of great value in overcoming both voluntary and involuntary muscular resistance. The tincture of opium, in half a drachm dose, with an ounce of camphor mixture, will generally relax the spasm; or may be repeated in two hours. Sometimes a spasmodic attack assumes an intermittent character, returning every day or two; and in such case, quinine has proved curative. With an *inflammatory* or congestive state of the urethral passage, as evinced by a turgid penis and tender perineum: local bloodletting from the latter region by cupping, or a dozen leeches, will often effectually subdue this occasion of resistance. After either kind of auxiliary treatment, the introduction of a catheter can generally be accomplished. Recourse to auxiliary measures may be deemed advisable *before* attempting to pass an instrument, and certainly this would be better than any risk of injuring the urethra by rough manipulation.

Forcible catheterism, or forcing the stricture as it is termed, will rarely be justifiable; and never in the sense of thrusting a catheter anyhow into the bladder. The forcible dilatation or rupture of an old indurated stricture, as by Holt's operation, offers an occasional resource for the relief of retention.

As a rule, when a catheter has been got into the bladder for the relief of retention of urine, the instrument had better be kept in, rather than encounter fresh difficulties in its introduction. Hence a gum-elastic catheter is preferable to a metallic instrument. After a few hours, or a day or two, according to circumstances, the instrument may be withdrawn.

Having failed to relieve the bladder by catheterism, recourse must be had to other procedures, in a variable period of thirty-six hours to two or three days, earlier or later, according to the amount of retention and the state of the patient.

Incision of the Urethra through, or behind, the Stricture.—The first-named point of incision,—through the stricture—is in fact perineal section; and the second—behind—may be performed in a precisely similar manner. The one has the advantage of relieving the stricture as well as the retention; the other leaves the stricture untouched, and it is performed without a guide in the urethra, by carefully deepened incisions so as to hit the passage; the finger having been introduced into the rectum to indicate the point in front of the prostate—the membranous urethra, and which is even perceptible by a bulging in the perineum from the propulsion of urine into the dilated portion of urethra behind the stricture as the patient strains to micturate. This procedure was recommended by Guthrie and Liston, and is preferred by Mr. Spence, though it has now generally given place to puncture of the bladder per rectum. Both these urethral modes of entering the bladder have the advantage of not directly opening the bladder, and, in relieving retention, they also release any extravasated urine, or matter which may have formed in the perineum.

Puncture of the Bladder through the Rectum.—Having emptied the bowel by an enema, the patient is brought to the edge of the bed and his legs held apart as for lithotomy. The Surgeon then introduces the left forefinger, oiled, into the rectum, and feels for the posterior margin of the prostate; just beyond which point, bulging fluctuation should be perceptible, especially on tapping the hypogastric region with the other hand. The long curved trocar and canula is then passed along the concavity of the finger, as a guide, to the same point in the middle line, and pushed upwards into the bladder; transfixing the rectum and the base of the bladder, in the *trigone* of the latter organ where it is uncovered by

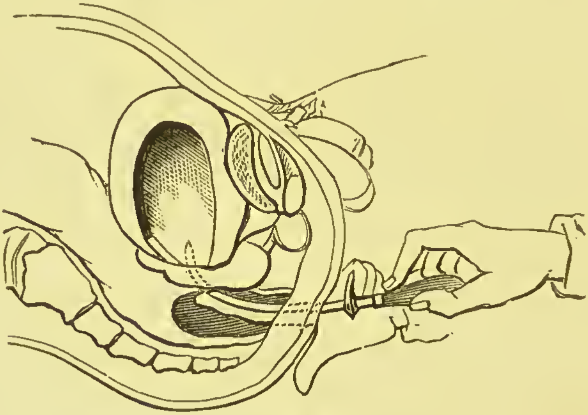

Fig. 58.

peritoneum (Fig. 58). This space is free from adjoining parts; the prostate in front, the reflexion of the peritoneum behind, the vas deferens and the seminal vesicle on either side. The trocar is now withdrawn, the bladder emptied, and the canula retained by means of a waist-bandage and tapes. In performing this simple operation, two additional practical points are worthy of notice; in passing the instrument along the finger, let the point of the trocar be withdrawn into the canula, to avoid wounding the bowel; and leave the canula in, but only just within the bladder, to prevent any irritation of the mucous membrane by the edged-end of this tube. It is allowed to remain for a few days, until urine flows by the natural channel, or until stricture of the urethra or other obstruction has been overcome.

The value of puncture by the rectum has been variously estimated. Mr. Cock, who has performed this operation in a large number of cases, is led to very favourable conclusions respecting it; that it is more easy of performance, and less dangerous in its results, than any mode of entering the bladder for the relief of retention. The objections to the operation are—not so much the liability of perforating the peritoneum and seminal vesicles, both of which parts may with care in performing the operation be avoided—but the liability to urinary infiltration, pelvic inflammation and abscess between the rectum and bladder, and a persistent fistulous opening. In one singular case that Mr. Erichsen relates, rectal flatus became diffused through the cellular tissue of the pelvis and down the thighs and nates; an emphysematous condition from which the patient died.

Puncture through the rectum is appropriate only when, —with retention from stricture, there is no sign of abscess or extravasation in the perineum, the urethra is apparently not dilated behind the stricture, nor the prostate much enlarged (Fig. 59); and a catheter cannot be passed, under the influence of opium or chloroform, with care and patience. As a rare complication, an abscess may have formed between the bladder and the rectum; or a cyst in this situation has been known to cause symptoms of retention, unrelieved by puncture per rectum, the trocar having entered only the cavity of the cyst. These circumstances will considerably restrict the cases for having recourse to this operation. Indeed, I believe it to be quite an unnecessary procedure, for the relief of retention, in ninety-nine cases out of a hundred.

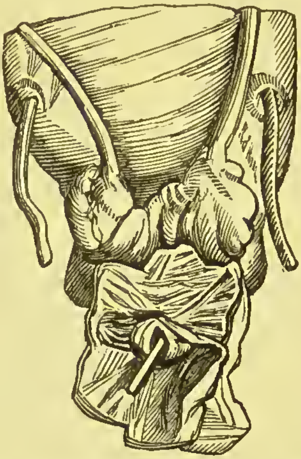

FIG. 59.—Roy. Coll. Surg. Mus., 2,045. A greatly enlarged prostate, with puncture per rectum; the trocar had penetrated in front of the enlarged gland, and thus the bladder was not entered, but the prostatic urethra. (E. Cock.)

Puncture of the Bladder above the Pubes is easily performed. A vertical incision in the middle line, and just above the symphysis pubis, is made to the extent of about two inches, and carried down through the linea alba, so as just to admit the tip of the finger to reach the distended bladder below the peritoneal fold, which will have receded owing to the state of distension. An assistant steadies this organ by even pressure with his hands against the abdominal wall, on either side; and a long curved trocar is entered downwards into the bladder (Fig. 60), the urine drawn off, and the canula allowed to remain for a few days as may be necessary. It is secured by tapes and a waist-bandage.

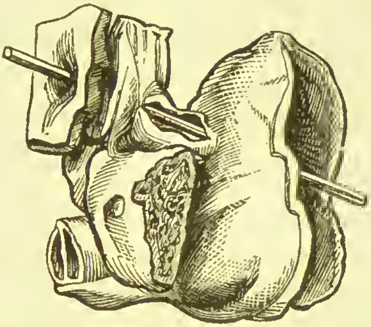

Fig. 60.—Roy. Coll. Surg. Mus., 2,043. Supra-pubic puncture of the bladder, for retention of urine, four years before death. The tract of the passage from the linea alba to the anterior wall of the bladder is partly laid open. Great enlargement of the prostate, the middle lobe projecting over the vesical orifice of the urethra. The patient, seventy years old, had symptoms of enlarged prostate for sixteen months before the operation ; a canula was retained in the bladder for nearly six months, and thus he resumed his business. Then a catheter was passed through the urethra into the bladder, with some difficulty in overcoming the enlarged prostate, and the canula was withdrawn. Owing to atony of the bladder, the catheter had to be introduced twice daily. Symptoms of stone in the bladder set in, with renal pain ; the supra-pubic aperture re-opened and discharged purulent urine, and death ensued from exhaustion. One large stone and several small ones were found in the bladder; and the ureters and pelves of the kidneys were full of pus. · (Langstaff.)

This operation was habitually practised by Maisonneuve, and strongly advocated by Mr. Paget, of Leicester, and is still in favour with some Surgeons of experience. It has been repeated often in the same case—as many as six times in eight days, without any adverse symptoms. Supra-pubic puncture is not, however, generally resorted to. The objections are, some risk of urinary infiltration, or of a fistulous opening remaining. But there may be no alternative between supra-pubic puncture and perineal section,—when, with impassable stricture, the prostate is considerably enlarged. Rectal puncture may then be absolutely impracticable, from the impossibility of reaching with the finger behind the enlarged prostate. *Aspiration* above the pubes is the safest method of evacuating the bladder, and is practicable whatever may be the cause of retention. This procedure may also be repeated as often as occasion requires, without any evil effects. In one case, twenty-three punctures were made within eight days; in another, eleven punctures were made within a small area—the size of a ten-cent silver piece; and in neither case, not the slightest untoward symptoms ensued. As being far the easiest method of entering the bladder for the relief of retention, I have practised aspiration under all circumstances, pending other measures. A boy, with ruptured urethra, was thus relieved immediately; and from an old man, with enlarged prostate, I drew off a quart of urine. The operation—scarcely worthy of the name—is readily performed, by entering the needle of the aspirator in the middle line, just above the pubes, and with a sharp thrust through the abdominal wall into the bladder. As the urine runs off into the exhausted receiver, and the bladder collapses on the needle, its point may wound the mucous membrane. Hence, it is preferable to use the fine trocar and canula, in connection with the aspirator.

The method of supra-pubic puncture by aspiration allows time for renewed attempts to enter the bladder per urethram; rectal puncture, therefore, is in my judgment even a less justifiable resource than formerly. Thus, it often happens that soon after the relief of retention by aspiration, the attack arising from temporary prostatic congestion subsides, reducing the enlargement, so that a prostatic catheter—metallic or flexible, can then be introduced.

Permanent Relief of Retention.—In treating the causes of retention, as arising from obstruction to the passage of urine, it not unfrequently happens that, eventually, the causative condition—be it stricture or prostatic hypertrophy—so gains ground, that the bladder is never completely emptied of its contents—there is always partial retention; recourse to catheterism becomes necessary with increasing frequency; the introduction of an instrument into the bladder becomes more and more difficult; the bladder, provoked by the constant presence of some urine, falls into a state of chronic cystitis, demanding the yet more constant relief of retention; and ultimately the patient is worn out by suffering. What is to be done?

Under these circumstances, in the course of *urethral stricture,* one operative procedure after another may have been tried in vain; "splitting" of the stricture having failed in its result, "urethrotomy"—internal or external — as perineal section, has been followed by the same issue; the stricture has recurred; it is still, or has become, all but impermeable; and thus the relief of retention and its consequences have been only temporary. The patient must die, at no distant period.

Can any operation be devised with a view to the *permanent* relief of the bladder?

In a case of old-standing stricture under my care—which had been subjected to every known method of operation, and had finally resisted them all, in the hands of very competent Surgeons—there remained one small fistulous opening in the perineum; and I noticed that this established outlet to the urine afforded great relief to the patient, compared with the usual state of such patients, who laboured under the same amount of stricture, and had borne the trial for the same lengthened period. Whenever, from any circumstance, the fistulous channel in the perineum became narrower, so as to interfere with the constant discharge of urine, I noticed that this man's general health relapsed; but, that after passing a probe to clear the way for constant drainage, he speedily regained his former sleep and comfort. Acting on the clinical suggestion thus given in this case, I determined to perform perineal section once more, just to gain the chance of overcoming the great tendency to recontraction of the stricture, by vigilant dilatation; or, that failing, to see the effect of maintaining the perineal channel from the bladder, which I should then have at command. The operation had to be accomplished by following up the fistulous passage which led to the membranous urethra behind the seat of obstruction—

for no kind of instrument could be got through the stricture, which was gradually divided from behind forwards. After operation, the stricture slowly returned, but the *perineal* channel remained more patent than ever; and I was agreeably confirmed in my belief as to the previous efficacy of this natural outlet for the urine, by observing the advantage which a larger and better-placed aperture afforded for the permanent relief of retention.

Puncture *per rectum* would be obviously out of the question, as a method of establishing a permanent opening into the bladder; seeing that a fistulous passage in that situation would become a fæcal communication.

Supra-pubic puncture has led to the same gratifying result as that obtained by a perineal outlet in my case. Mr. Paget, of Leicester, gained some such experience, in relation to the curative treatment of retention, from the final results of puncturing the bladder above the pubes, in old-standing cases of stricture; for although the operation was not performed for the purpose of establishing a permanent opening, the tube used at first subsequently became for years the channel by which all urine passed.

In *advanced* prostatic hypertrophy, the increasing suffering from almost complete retention, and the incessant passing of a catheter, at last culminates in the crisis of demanding, if possible, some permanent means of relief. Here again, rectal puncture cannot be entertained, even if such a procedure were practicable, in the case of a very large, massive prostate; and a perineal outlet for the urine would be equally impracticable. In such extreme cases of prostatic retention, Sir H. Thompson was induced to adopt supra-pubic puncture of the bladder, thus to establish a permanent opening in that situation; he having witnessed the comfortable condition of the patients who had been relieved by the result of the analogous procedure, in Mr. Paget's cases of stricture. The operation is simple, and safe; but it must be remembered that the bladder is never distended, as probably in cases of retention from stricture; and therefore the organ does not rise up above the pubes to meet, as it were, the operator. Accordingly, a large, hollow sound, having a strongly-marked curve, and which contains a bulbous-ended stylet, is introduced through the urethra, up the bladder, until the end can be felt just behind the symphysis pubis. This instrument is then held by an assistant, who must retain it in position, as the point to be reached by supra-pubic incision. The incision is made in the middle line, at the upper margin of the symphysis, for the bladder is scarcely free of peritoneum; and the integument being divided to the extent of not more than three-quarters of an inch in length, just sufficient to admit the forefinger tightly, the linea alba is felt, and divided to the same extent; then, on passing the finger down closely behind the symphysis, the end of the sound is felt projecting in the bladder, and a small opening made just to expose its point. The operator now taking the handle of the sound, makes the end protrude in the wound, the bulbous stylet is withdrawn, and a tube passed into the end of the hollow sound, and through its whole length. On withdrawing this instrument, by the urethra, the tube follows into the bladder, and is left there. In five cases, this operation has yielded more or less satisfactory results; viewing it as a last resource, to mitigate the sufferings of patients whose fate was already sealed.

Puncture of the Bladder through the Symphysis Pubis.—An ordinary hydrocele trocar of medium size is introduced, with or without a small preliminary incision, about the centre of the symphysis from above downwards, and in a direction about right angles to the vertical axis of the body. It is thrust onwards, somewhat obliquely downwards and backwards towards the sacrum, this direction being varied according to circumstances; a flexible catheter is then passed through the canula and retained by a tape. Dr. J. M. Brander, of Jersey, in 1825, first proposed this operation; and several successful cases have since occurred in his practice, and in the hands of other Surgeons. But no advantage is gained by entering the bladder through the pubic symphysis, the organ being equally free of peritoneum just above the pubes, especially as the bladder rises in the abdomen from increasing retention of urine. I, therefore, never have recourse to the operation in this situation.

In the *Female,* retention of urine may arise from certain *special* causes of mechanical obstruction:—as from the accumulation of menstrual fluid owing to imperforate hymen; during pregnancy, or parturition, from compression of the gravid uterus or the head of the child upon the urethral canal; and uterine tumours, or displacements of the uterus may act in like manner. Hysterical retention of functional and paroxysmal character, is perhaps peculiar to the female sex.

Treatment consists in the removal of any cause of retention. Thus, in hysteria, remedial measures must be directed to the constitutional condition; and when retention results from some obstruction to the passage of urine, the particular cause must be discovered, and overcome if possible. The introduction of a catheter may be necessary to afford relief, a procedure with which, in regard to the retention of urine in a female patient, the young Surgeon should be familiar, that he may perform it expertly, and with delicacy.

The female catheter is a silver tube, about five inches in length, somewhat flattened, and slightly curved upwards towards the vesical end. It is provided with half a dozen lateral holes, on either side of this end; and the outer extremity is fitted with a silver plug, which can be withdrawn so far as to allow of urine transmitted through the tube, to escape from a branched outlet just below. This instrument is also made as a double tube, down to the lateral apertures; the inner portion sliding easily within the outer tube, so as to admit of elongating the catheter to the extent of two inches, if necessary. The plug is finished off with a ring, to retain the instrument in the bladder by means of a tape. When the urethra is longer than usual, and altered in direction, as during pregnancy, a gum-elastic catheter will be better adapted for use.

In passing the catheter, it is quite unnecessary to uncover the patient; unless in an exceptional case, where, owing to some diseased condition about the urethra, its external orifice cannot be found. The patient lying recumbent, with her legs a little apart, and a pillow under the buttocks, if requisite to raise the pelvis of a stout person; this arrangement offers every facility for passing the instrument, under the clothes. On introducing the forefinger of the left hand into the opening of the vagina, just above its upper margin lies the orifice of the urethra—and which can be felt as a small round opening, set in an elevation, this being sometimes swollen and enlarged, under the circumstances of urinary retention. Keeping the left hand in position, the catheter is slid with the right hand upon the palmar surface of the left forefinger, and is thus guided into the urethral orifice. Another method is, to take the clitoris as an indication of the urethral meatus, lying below. Placing the forefinger on that spot, within the commissure of the nymphæ, or inner labia of the vulva, the catheter is passed downwards, and with an inclination—backwards, it will almost immediately enter the meatus.

Extravasation of Urine.—This may result from unrelieved retention of urine, in stricture; and generally, the urethra is ruptured behind the seat of obstruction, the bladder very rarely. But the urethra is also liable to be ruptured by the obstruction arising from an impacted calculus; or by a false passage, from unskilful catheterism; by a fall across a beam, or kick on the perineum; or by fracture of the pelvis, implicating the urethra. In either way, extravasation of urine takes place.

Rupture of the Urethra occurring behind the seat of stricture, the point of rupture is almost invariably the membranous portion of the urethra and just in front of the triangular ligament. Here, the urethra is naturally weak, and has become dilated in the form of a sacculus or pouch, by the constant distending pressure of the urine, resisted by the strictured passage in front (Fig. 61). Under this pressure, the weak and dilated urethra tends to yield, and may give way in a straining effort to pass urine; but the immediate cause of extravasation is more often ulceration of the mucous membrane, either from urinary irritation, or as the result of an abscess forming close to this part of the urethra, externally, and which induces ulceration into the canal. The urine escaping from the urethra, or becoming extravasated, into the adjoining cellular tissue, gradually infiltrates this texture beneath the deep layer of the superficial fascia in the perineum; and the fluid following the

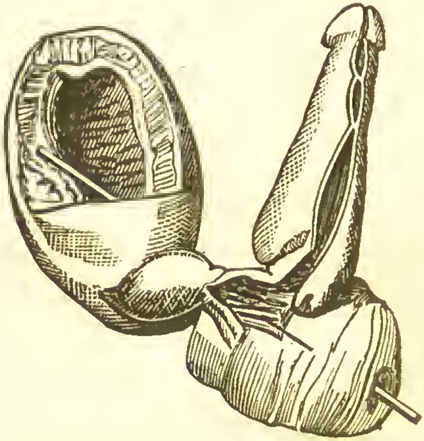

Fig. 61.—St. Thomas's Hosp. Mus., DD. 23. Stricture of the spongy portion of the urethra, in the form of two tight annular contractions, and old puckered cicatrices and membranous bands, transverse and longitudinal, in the membranous and prostatic portion of the canal; with dilatation of the urethra behind the annular strictures, great thickening of the bladder from hypertrophy of the muscular coat, and rugous state of the mucous membrane. A piece of whalebone, introduced through a perineal incision, indicates the course of a false passage along the side of the prostate gland, and which penetrates the cavity of the bladder.

boundaries of this fascia, it forms a bag, limited by the base of the triangular ligament below, and the rami of the pubes laterally; thence continuing upwards, the scrotum and penis become infiltrated, then the lower part of the abdomen and outwards to the line of Poupart's ligament on either side; but there is no extension downwards on the thighs.

The *symptoms* of extravasation are remarkable :—the characteristically bounded swelling, and its increasing size and extent; the scrotum and penis especially becoming enormously distended, the one perhaps to the size of a large cocoa-nut, the other to that of a Bologna sausage; a sensation of sudden relief of the distended bladder is immediately followed by an acute burning sensation in the perineum; gangrenous inflammation of the cellular texture soon supervenes, the skin assumes a dusky red hue, purplish or black gangrenous spots appear, and frequently one such patch is seen on the dorsum of the penis. Ultimately sloughing of the skin and cellular texture of the scrotum exposes the testicles bare and pendulous. Sometimes, the urethra bursts just in front of the bulb; when, in addition to the swelling of ordinary extravasation, the urine infiltrates also the corpus spongiosum of the penis, which is soon followed by gangrene of the glans, in the form of black spots or having a generally black appearance; thus indicating this further urinary extravasation (Fig. 62). The constitutional disturbance, commencing with a shivering-fit, is soon that of low typhoidal depression; a rapid feeble pulse, dry brown or black tongue, and muttering delirium as death approaches.

Urethral rupture occurs usually in three or four days, or in the course of a week from retention; but the period will vary, according as the bladder may be relieved by a dribbling incontinence or an occasional overflow, and will also depend upon the dilatability of the organ, and the quantity of urine secreted.

The *diagnosis* might be misled by the general resemblance of the swelling to that of phlegmonous erysipelas; but the above characters, taken in connection with the retention of urine, will indicate the nature of the attack.

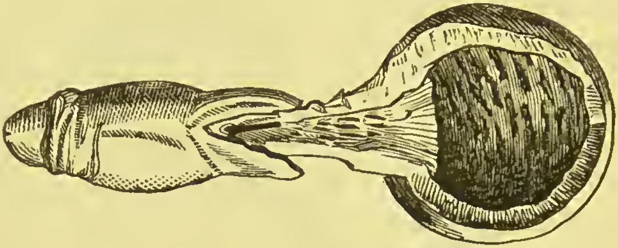

FIG. 62.—Roy. Coll. Surg. Mus., 2,548. ' Gangrene of the body of the penis, from extravasation of urine into the corpus spongiosum owing to ulceration of the floor of the urethra, about three inches from the external meatus. (Hunterian.)

When the urethra is ruptured more deeply in the perineum—behind the triangular ligament, as may happen from a kick or other injury to that part of the canal, the usual characteristic boundaries of urinary extravasation are not observed. The urine infiltrates the cellular texture, backwards, into the pelvis, around the rectum and bladder, restricted by the recto-vesical fascia; and the fluid extends also downwards into the thighs—so that in one such case, I felt quite a splashing sensation down to the knees, when the adductor muscles were moved.

Treatment.—The primary indication of treatment is to give an immediate, free and dependent outlet to the extravasated urine, with the fetid purulent fluid and sloughs of cellular texture which soon form. This indication is, therefore, both preventive and remedial. Hence an incision or two should be made in the scrotum on either side of the middle line; exposing the cellular texture, and extending from the front to the back of the bag. Another incision may be made on the dorsum of the penis, and perhaps another over the pubes. A quantity of strong-smelling or ammoniacal urine trickles out, and continues to ooze for hours or days; at the same time, the peculiar appearance of the cellular texture,—its pearly-white colour and tension, or its opaque, sodden and matted appearance, exhibits the urinary infiltration, or the supervention of sloughing. Tension having been thus relieved, a catheter can often be passed through the stricture into the bladder. This should be done at once, and the instrument retained in the usual manner by means of a waist-band and tapes. The catheter is left *unplugged*, that the urine may drain away from the bladder, and as the instrument occupies the *calibre* of the urethral canal, both these provisions will prevent any further extravasation. By this arrangement also, the ruptured urethra heals over the instrument. A large poultice or warm fomentation, or an antiseptic application, is placed around the scrotum and over the whole extent of the extravasation. The relief afforded by the incisions is almost instantaneous, the patient often soon rallying from the previous state of nervous prostration and low fever. Stimulants, in the form of wine or brandy, with supporting nutriment, may now be given advantageously; and bark with chlorate of potash, or ammonia, will prove very beneficial. Opium also is a most valuable agent; in the early period to counteract the nervous excitement which not unfrequently accompanies prostration, and afterwards when excitement sometimes prevails, to subdue it.

The subsequent treatment of sloughing and granulation, after a long and trying process of exhaustion and repair, must be conducted on ordinary principles. When the urethra has been ruptured by injury, the same plan of treatment is applicable.

Rupture of the Bladder—a very rare consequence of retention—is attended with extravasation of urine into the peritoneal cavity; or more commonly, below the line of the peritoneal reflexion, into the pelvic cellular texture, whence it may secondarily get into the peritoneum by ulceration.

The symptoms are sudden and acute abdominal pain, the patient usually feeling that something has given way; and there is overwhelming collapse. Dulness on percussion over the region of the bladder is now substituted by general abdominal fluctuation and distension, with total incapability to strain out a drop of urine. The most acute peritonitis, or diffuse pelvic cellulitis, sets in, according to the situation of the rent in the bladder. Maniacal delirium sometimes appears to supersede the collapse, but death ensues in a period varying from thirty-six hours to four or five days.

The *treatment* must be directed to the immediate prevention of any further extravasation of urine, and to the evacuation of that which has already escaped from the bladder. For this twofold purpose, the measures to be adopted are the same as when the bladder is ruptured by injury. (See p. 109.)

Suppression of Urine—Anuria—differs entirely from retention, there being no urine secreted.

The symptoms are those of uræmic blood-poisoning, owing to the retention of urea, and other urinary constituents, in the blood. Commencing sometimes with a rigor, an aching pain in the lumbar region is accompanied with a sense of exhaustion, succeeded by vomiting and feverishness of a typhoidal character, with urinous-smelling perspiration; delirium, convulsions, and coma supervene, and the patient dies in the course of three or four days, or perhaps a week. The suppression is sometimes transient; urine is re-secreted, and the perilous symptoms pass off. No difficulty can be experienced in distinguishing any such attack from that of retention of urine. With suppression, in addition to the other symptoms, no urine is passed, or only a few drops, of a high-coloured, concentrated character, and the introduction of a catheter fails to obtain any; nor is there supra-pubic dulness on percussion, the bladder being empty.

This arrest of the urinary secretion may be referable to various causes—a symptom of many diseases. Commonly arising from disease of the kidneys, as congestion; or of a structural character, as in Bright's disease, suppression of urine not unfrequently proceeds from some powerful impression on the nervous system, as the shock of injury or surgical operation. But it may also occur in the course of fevers, or other blood-poisoning. According to this diversity of causation—by renal or systemic disease—the suppression of urine may be gradual and incomplete, yet fatal; or an attack, sudden and complete, but perhaps of temporary duration.

Treatment can do very little to restore the secretion of urine. But the effort should be promptly made, by cupping the loins, or dry-cupping; with sudorific medicines, the warm-bath or hot-air bath, in order to promote sweating, and purgative enemata, thus also to aid the elimination of excrementitious matters. Whether stimulant diuretics should be administered to force the kidneys to renew their function, is a very questionable practice, both in regard to its efficacy and safety. For this purpose, however, cantharides has been given in grain doses, coupled with the application of a large blister to the loins; and this method of treatment is said to have proved successful in some instances.

Obstructive suppression of urine presents a different clinical history to that which depends on renal, or systemic disease. It arises commonly from the impaction of a renal calculus in the ureter of one kidney; the other organ being diseased, or incompetent for a full secretion of urine. At first, therefore, some urine is secreted; but even this is not of a sufficiently excretory character—it being pale and watery, and having a very low specific gravity, although without albumen. This partial secretion of defective urine is more or less completely intermittent; to-day, some urine is passed; to-morrow, less; then perhaps none for two or three days; followed by some re-secretion, and so on. Thus, in the course of suppression, a variable quantity of urine is passed, amounting to a few ounces, or possibly pints, ere complete suppression prevails.

The *symptoms* of anuria proceed slowly; a week, perhaps, elapsing before marked indications of uræmia ensue; but then the patient succumbs rapidly, in three or four days, as in the usual period from suppression depending on other causes. The symptoms themselves are also modified in suppression from obstruction. The cerebral functions are less obscured. Wandering delirium and drowsiness may subside into stupor rather than coma; but, not unfrequently, rational consciousness is retained at intervals up to the last. Muscular twitchings set in, but rarely convulsions; and the pupils become contracted. Profuse perspiration often supervenes, but the sweat has not a urinous odour. The patient lying recumbent in this state, with the laboured respiration of typhoidal oppression, gets weaker and weaker; at length dying from exhaustion as much as from uræmia.

Treatment should be directed to the removal of the obstructive cause of suppression, which is usually an impacted calculus in the ureter. Whatever measures, therefore, may avail for the treatment of renal calculus—to promote its descent into the bladder—may be here applicable. It does not appear that the administration of stimulant diuretics, to force the other kidney to an increased or compensatory secretion, would prove effectual, but rather prejudicial.

URINARY ABSCESS. — Suppuration circumscribed by plastic matter, forming an abscess, is liable to occur close to the urethra in some part of its extent. It may arise from any source of urethral irritation; usually the collection of urine in the dilatation behind a stricture, or from urethritis, or simply from irritation after the passing of instruments. The suppuration is apparently induced either by ulceration of the mucous membrane allowing of slight urinary extravasation into the sub-urethral cellular texture (Fig. 63), and which thus becomes a direct source of irritation; or, abscess may perhaps result from the influence merely of the irritation in the adjoining portion of the urethral canal. In the one condition, abscess, proceeding from the canal, may open externally; in the other condition, abscess forming outside the canal, may open into it, and externally. Urinary abscess is liable to form in various situations, in relation to the urethral tract; and it is thence designated, *perineal*, *scrotal*, *intra-pelvic* or *vesico-rectal*, and *ante-scrotal* or *penile*. This also represents the order of frequency in the situations of such abscess.

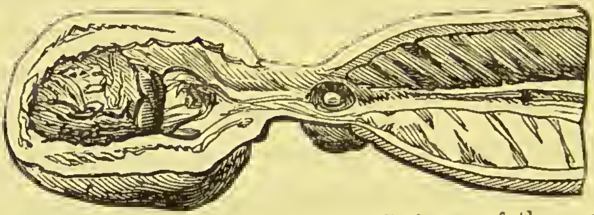

FIG. 63.—Roy. Coll. Surg. Mus., 2,551. Stricture of the urethra, with small abscess in the bulb, *communicating*. Bladder thickened. (Liston.)

A small, circumscribed, hard, and painful tumour is felt, in the neighbourhood of the urethra; which scarcely attains any considerable size, unless in the perineum.

It is not attended by much constitutional disturbance. (See p. 352.)

Vesico-rectal abscess may form without any perineal swelling to attract attention. Rectal examination will discover a tense fluctuating tumour in front of the bowel, which explains the previous symptoms of intense pain and bearing-down sensation, of which the patient complains. But urinary abscess occurs so very rarely in this situation, that it might remain undiscovered. At length bursting into the rectum, or coming forward in the perineum, the nature of the case may be declared.

Treatment.—Early incision is absolutely necessary, to prevent further extravasation of urine, or the establishment of urinary fistula. A free, and often deep, incision in the middle line, will give instant relief to tension, or afford exit to matter. The part should then be well poulticed.

Urinary Fistulæ commonly result from urinary abscess, communicating with the urethra, and externally. The internal opening is generally in the membranous urethra—just behind the usual seat of stricture; the external opening is most frequently perineal or scrotal (Fig. 64); and the intervening parts are traversed by the fistulous passage, or passages in various and often devious routes. Sometimes the fistula is antescrotal or penile; and here the communication with the internal or urethral opening is almost direct. Less frequently, the openings of urinary fistulæ are found in the groins, the upper part of the thighs, the adjacent part of the nates, or even above the pubic symphysis. Even more rarely, a perineal urinary abscess has opened into the rectum; feculent matter and flatus escaping through the urethra. In size, the fistulous passages differ considerably; some admitting only the finest probe, others readily the finger. In point of number also, they vary remarkably; penile fistulæ being usually single, whereas scrotal and especially perineal fistulæ are often numerous. Fifty-two openings Civiale found in one such case. The surrounding structures differ so much in their condition as almost to warrant the distinction of urinary fistulæ into two classes: the *simple* or healthy fistula, and the *indurated* fistula. In the latter condition, the fistulæ are sometimes connected with cavities secreting pus, and detaining in their interior some quantity of the urinary secretion. The surrounding parts share the induration; the scrotum and penis becoming enormously enlarged and brawny, or almost cartilaginous. Another and more

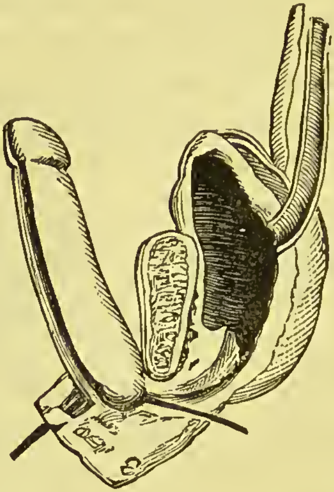

FIG. 64.—St. Mary's Hosp. Mus., H. *h*. 9. Perineal abscess, communicating with the urethra, just in front of the membranous portion, and having a fistulous opening externally. (Samuel Lane.)

important distinction, which characterizes a class of urinary fistulæ, is that wherein the urethral opening results from actual *destruction* and *loss of substance*, by sloughing; in consequence of urinary extravasation, phagedænic ulceration, or mechanical injury. A portion of the floor of the urethra having been destroyed, and the tissues intervening between it and the external surface, the urethral mucous membrane of the upper aspect or roof of the canal becomes visible from the outer orifice of the fistula. Such apertures may be found in similar situations to those of abscess-fistulæ; as perineal, scrotal, and ante-scrotal or penile fistulæ.

The symptoms of urinary fistula, having reference to the act of micturition, are characteristic of the existence of such fistula; and are tolerably distinctive as to its situation, size, and mode of origin.

In all urinary fistulæ, the urine escapes partly, at least, by the fistulous opening, or openings; in the latter condition, the urine spurting out perhaps as if it were issuing from the rose of a water-pot. This may be often seen in perineal and scrotal fistulæ, where numerous openings frequently co-exist. The situation of the internal opening is less correctly indicated, owing to the devious routes of the fistulous passages. But the seat of stricture will supply this information. According to the size of the fistulous communication, more or less urine will escape through the unnatural passages; and proportionately, less or more by the urethra. And the mode of micturition in this respect is tolerably diagnostic of fistula which results from destruction of a portion of the urethral canal; the whole or nearly the whole of the urine then passing by the artificial channel in a full stream.

Treatment.—When a stricture, followed by abscess, is the cause of the fistula, the primary indication of treatment will be the removal of that condition. This may be done in the usual manner; by dilatation, internal urethrotomy occasionally, external urethrotomy more commonly,—and usually the perineal section, owing to the situation of the stricture. Having thus succeeded in enabling the urine to flow by the natural channel, the fistulous passages are set at rest, and they not unfrequently contract and close. Thus, both *simple*, and even indurated, urinary fistulæ may be cured.

But *old, indurated* fistulæ are indisposed to heal, although the original cause has been thus removed. Recourse must be had to additional treatment for this purpose. The measures remedial in chronic fistulæ generally, are here also appropriate, and may have to be tried in succession. They are chiefly: stimulating applications to the fistulous tract; compression; and incision along the course of the fistula to induce healing from the bottom. Of *stimulating applications*, various agents have been employed; in the form of injection by means of a fine syringe, as tincture of cantharides, solutions of nitrate of silver, sulphate of copper or of zinc. A probe coated with fused nitrate of silver may be passed along the tract occasionally, and this will often succeed in causing contraction. The actual cautery is sometimes curative, applied in the form of a red-hot wire, or the galvanic-wire cautery, which can be conveniently introduced along the tract before being heated by the current. In the treatment by stimulation, care must be taken not to close the superficial part of the fistula, which would result in the reproduction of abscess, but to heal from the bottom. *Compression*, by means of an india-rubber air-pad, applied to the perineum, has proved successful in some cases of perineal fistulæ. But I have no experience of this method of treatment. *Division* of the fistulæ along their course nearly to their origin in the urethra, can be accomplished as usual, with a grooved director and narrow blunt-pointed bistoury. Several passages may be thus thrown into one, and strips of lint should then be inserted to provoke granulation from the bottom of the tract.

During recourse to these measures for the cure of urinary fistulæ, any passage of urine along their course must be prevented, by regularly using the catheter three or four times a day. The patient may be instructed how to do this for himself, at every call of nature.

Respecting the eligibility of these modes of treatment; in long, narrow, and tortuous fistulæ, stimulation or perhaps compression will be the most appropriate; when the fistulæ are large and numerous, division is more suitable, the perineum and scrotum being sometimes quite riddled in all directions.

Sometimes a *blind* internal urinary fistula may be suspected,—having no opening externally, but communicating with the urethra by a minute orifice; and which results in the formation of an indurated knob, lasting for months or years. This is produced by a slight leakage of urine. But every now and then the knob becomes tender, enlarges, and gets softer, threatening to suppurate, owing to a little additional urinary infiltration. These attacks occur when the stricture is more contracted than usual, and thus the stream of urine is delayed in passing; perhaps also the urine itself being more irritating than ordinarily. The treatment of this condition should be to dilate the stricture to at least its former size; so that, as the urine is passed more freely, there will not be sufficient time for leakage to take place. I have thus succeeded in reducing the urethral lump of a blind fistula to nearly its former size, and certainly to a quiescent state, for a time. But if the swelling is about to burst, it should be laid open with a bistoury, thus forming a complete fistula, and the stricture treated by dilatation.

Larger-sized urethral openings, in consequence of actual *destruction* of some portion of the wall of the canal, require operative interference of a plastic character, to repair the loss of substance.

Urethro-plastic operations are designed to effect reparation in one of two ways; either by simple closure of the fistulous aperture, or by borrowing the surrounding integument to accomplish this object. These procedures are severally applicable according to the part of the canal where the opening exists.

Perineal fistula may admit of closure by simply paring the edges down to the urethra, and uniting them with quilled sutures, or by Bozeman's buttons.

Ante-scrotal or penile fistula is much more difficult to close, owing to the want of substance in the coverings of the urethra at this part of its extent, and the liability of the part to disturbance by erection of the organ or other motion. When the opening is *small*, Dieffenbach's mode of closing it may be applicable. It consists in first stimulating the edges, by frequently touching the surrounding skin with the strong tincture of cantharides, the day before the operation; and then using the "lace suture." A sound is introduced into the urethra beyond the opening; the operator takes a small curved needle, sharp at the point but not at its sides, armed with a stout silk waxed thread, and by means of a needle-holder introduces it beneath the skin at about three lines from the border of the fistula. The needle is carried deeply, but not into the urethra, and made to emerge at another point; then dipped again, and so on by three or four stitches, carried round the opening, until it emerges at the point of entrance. The thread, thus embedded in the cellular texture around the fistula, is drawn by its two ends together, so as to close the opening; and then fastened by a knot. In three or four days the ligature may be divided and drawn away. A *larger-sized* aperture will probably require some substitution of the surrounding skin; and this may be accomplished by Nélaton's operation, as follows:—The edges of the fistula having been pared, a transverse incision is made below the fistula, with a tenotomy knife; the blade is then passed through the incision, beneath the skin around the fistulous opening (Fig. 65); thus forming a detached area of integument, to the extent of about an inch, which is brought together over the opening, and the edges united by a few points of fine suture. This procedure may sometimes be advantageously modified by making lateral incisions, instead of the transverse incision below; the bands of integument having been detached subcutaneously, any tension upon the fistulous opening is thus removed; then, a slip of india-rubber is passed across the urethra under the flaps, to prevent any escape of urine, which would disturb the process of adhesion in the line of closure over the urethral opening.

During the course of reparation by any of these urethro-plastic operations, the urine must always be drawn off gently by a catheter, three or four times daily.

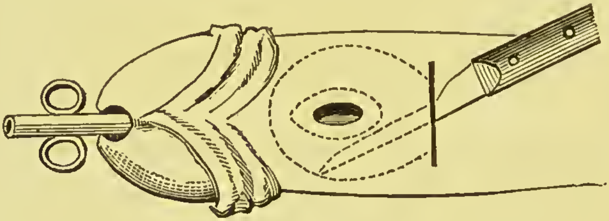

FIG. 65.

He who studies diseases of the bladder must have frequent occasion to meet with diseases of the rectum. This relation will have been noticed in connection with stone and urethral stricture; with either of which piles, and prolapsus of the rectum are often associated. But the bladder and rectum share the diseases, each of the other, owing to the immediate contiguity of these organs. Thus, fistulous communications are not uncommon, and demand the Surgeon's most anxious care and attention.

RECTAL FISTULÆ. — Fistulous communications are liable to form between the rectum and adjoining organs:

the bladder, as Recto-vesical Fistula, in the male; and the vagina, as Recto-vaginal Fistula, in the female.

(1) *Recto-vesical Fistula* is not often met with. It may result from disease, forming an ulcerative communication between the rectum and the bladder, as in cancer of the gut (Fig. 66); or be of traumatic origin, as from a wound of the bowel in the operation of lithotomy.

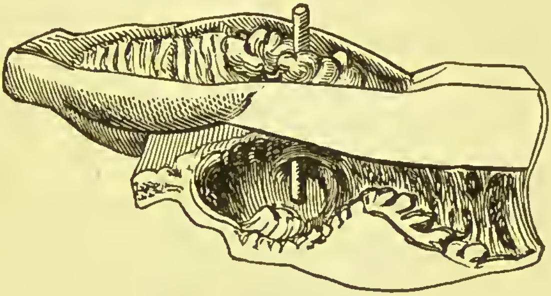

FIG. 66.—Roy. Coll. Surg. Mus., 1,269. Recto-vesical fistula, from cancerous ulceration. The ulcer of the rectum is deep and irregular, and extends from the level of the prostate gland for nearly three inches upwards; a soft, flat tumour, about two inches long, projects around the vesical aperture, just above the ureters. There was another such tumour, of smaller size, higher up on the wall of the bladder. All the tissues around the rectum were indurated and contracted. (Hunterian.)

Signs.—The escape and discharge of the contents of either organ—of urine *per anum*, of feculent matter and flatus *per urethram*—at once proclaims the nature of the lesion; while digital or ocular examination through a double-bladed anal speculum, will plainly detect the situation and size of the fistulous opening. When resulting from disease, the cancerous or simple nature of the fistula can thus also be readily discovered. Constant irritation, excoriation, and offensive odour accompany the discharge of urine and feculent matter; the patient leading a life of seclusion and misery.

Treatment.—The object is to close the fistulous opening; but the surgical procedure appropriate for this purpose must depend on the cause and extent of the opening. *Cancerous* fistula is incurable; and all that can be done is to palliate the patient's sufferings, by opiate and detergent injections, with constitutional support. Colotomy, in the iliac, or the lumbar region, is the only operative procedure which holds out the hope of relief. *Traumatic* fistula, if recent, and of small size, may perhaps be induced to contract and close, by introducing a pencil of nitrate of silver occasionally, or by means of the actual cautery,—a red-hot wire, or platinum wire heated by the galvanic current, or Pacquelin's cautery; an anal speculum being used to protect the bowel, and effect the cauterization exactly within the fistulous opening. An old, callous fistula, and of larger size, cannot be closed in this manner; it will be necessary to lay it open, and convert the rectal or anal into a perineal fistula, so that it may granulate and heal from the bottom. This is accomplished by passing a grooved staff through the urethra, and cutting down upon it; dividing the sphincter and intervening portion of bowel. A strip of lint is then placed in the wound.

(2) *Recto-vaginal Fistula* is usually of traumatic origin; the result of sloughing of the posterior wall of the vagina, from long-continued impaction of the head or the use of instruments during parturition. The size of the opening varies considerably, from that of a small perforation to a large portion of the posterior vaginal

wall. It may be complicated by laceration of the perineum.

Signs.—The discharge of feculent matter and flatus from the vagina at once shows the existence of a recto-vaginal communication; and examination with the finger, or inspection by introducing the duck-billed speculum, will reveal the situation and extent of the aperture.

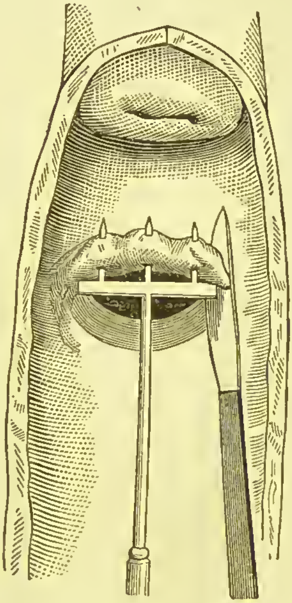

Fig. 67.

Treatment.—The procedure for closing a recto-vaginal fistula must be determined primarily, according to whether the opening be simple, or complicated with laceration of the perineum.

Simple Recto-vaginal Fistula, if recent, and of small size, may perhaps be closed by cauterization gently with nitrate of silver, a red-hot wire, or the platinum loop, applied within the opening; the anterior of the wall of the vagina being well raised by the duck-billed speculum. An old fistula, and of larger extent, must be closed by a plastic operation. The bowels having been thoroughly

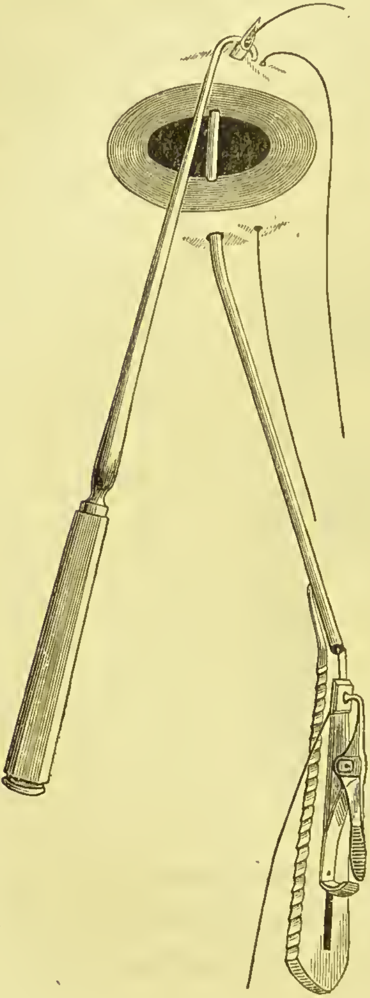

FIG. 68.

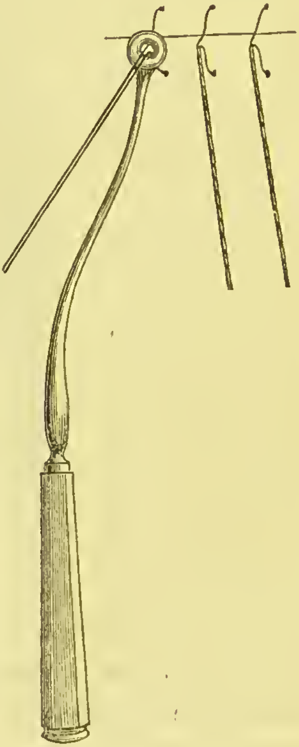

FIG. 69.

emptied by aperients, and an enema on the morning of operation, the duck-billed speculum is introduced, and the fistula, in the posterior vaginal wall, entirely exposed; the patient lying recumbent, with the legs raised and held apart, and the buttocks at the edge of the table, as for lithotomy. The Surgeon sitting opposite the perineum, he freely pares the margin of the opening (Fig. 67); then the edges are brought into even and easy apposition, transversely to the axis of the vagina; to effect which it will be necessary to divide the sphincter ani on either side, in order to overcome tension, and spasmodic muscular contraction after the operation. The sides of the opening are evenly secured in apposition by means of silver or platinum wire sutures; taking care to transfix the whole thickness of the gut, excluding its mucous membrane, and observing to bring the sutures through the vaginal mucous membrane half an inch beyond the prepared edges, above and below (Fig. 68), the suture-wires are fixed by a close twist of the wire across the line of aperture (Fig. 69), or they may be passed through a perforated leaden shield, overlying the aperature, then through split shot, which are clamped with forceps close upon the shield, so as to fix it upon the vaginal wall. But the latter mode of closure is now seldom practised. The ends of wire are snipped, and the operation completed. *After*-treatment is most important. It consists in preventing any action of the bowels for a week or ten days, by keeping the patient under the influence of opium, until firm union is established. A laxative aperient, or an enema of castor oil and gruel, may then be administered. Cleanliness is also essential to success; the vagina being syringed with cold water two or three times a day, and the urine drawn off by a catheter as occasion requires. About the end of a week, the sutures may be snipped through, and gently withdrawn. A small aperture, even a pin-hole opening, not unfrequently remains, and obstinately resists closure. This must be treated by touching with nitrate of silver or the wire-cautery. In one such case—after the usual operative procedure—I applied the actual cautery on seven different occasions, before I succeeded in closing the pin-hole aperture.

The *complication* of a *Lacerated Perineum* must be treated by the appropriate operation, the fistulous aperture being closed by paring, and sutures. I have thus closed a recto-vaginal fistula, and subsequently a laceration of the perineum, which existed in the same woman; and in whom also a tight annular membranous stricture of the rectum was cured, by dividing its free margin with scissors, at two or three points of its circumference, and which I then dilated as usual, by the occasional passage of a bougie.

This injury happens occasionally during parturition; in consequence of the large size of the fœtal head, or from rigidity of the perineum; or sometimes under operations, manual or instrumental, skilfully or unskilfully executed. During parturition, laceration or rupture of the perineum occurs in the passage of the fœtal head. It varies considerably in its extent and consequence. Perineal laceration may be regarded as of four degrees: that which is limited to the anterior edge of the perineum; that which extends backwards through the whole length of the perineum to the sphincter ani; that in which the sphincter is torn through; that in which not only is the sphincter torn through, but where more or less of the recto-vaginal septum is also torn. A combination of laceration and sloughing is sometimes met with; the perineum being torn through, and the recto-vaginal septum destroyed by sloughing from prolonged impaction of the fœtal head. The fissure, directly resulting from laceration and increased by loss of the septal substance, may be complicated also by the subsequent formation of dense bands of imperfect cicatrix; thus presenting the most difficult form of lesion in regard to treatment.

The *consequences* of laceration depend upon its extent. Whenever it passes beyond the anterior margin of the perineum, and especially when it involves the sphincter ani and perhaps the septum, there will be a tendency to prolapsus of the uterus and bladder, of the rectal mucous membrane, or of all these parts; and with the latter condition, as depending on the sphincter having given way, there will also be inability to retain the fæces—incontinence of fæces. This trouble is especially marked when the stools are loose or liquid.

Treatment.—Operative interference is absolutely necessary in all degrees of perineal laceration, except that of a slight rent in the front margin of the perineum. This will, generally, heal by rest and cleanliness, with perhaps an occasional touch of nitrate of silver.

The *operation,* in each of the other degrees of further laceration, is essentially the same; a plastic procedure, which consists in freely paring the edges of the fissure, and bringing them together by quilled sutures, to procure union by adhesion. *Prior* to operation, the patient's general health should be brought into the best possible state, and any source of local irritation removed; as these two conditions will mainly determine a successful result. The operation is then performed as follows:—The bowels having been thoroughly emptied, chloroform is administered, and the patient placed in a lithotomy position; a duck-billed speculum is passed into the vagina, so as to elevate the upper floor, and thoroughly expose the perineal fissure. This must then be freely pared throughout its depth and extent, on either side; thus to prepare two raw surfaces, together of nearly a horseshoe shape (Fig. 70).

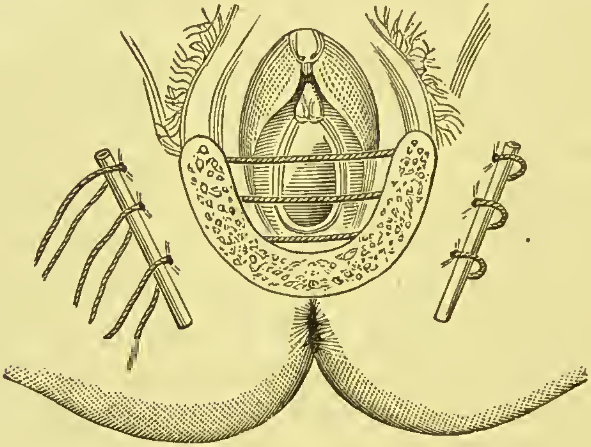

Fig. 70.

If the operation be performed within twelve hours of the occurrence of the injury, no paring of the surface is usually necessary. But occasionally an irregular mass of connective-tissue projects so as to interfere with neat apposition of the two sides of the wound. Such a mass may be snipped off. The parts are then brought together by suture. Beginning at the hindmost part, a moderately curved needle, either mounted on a handle or carried by forceps, is passed deeply into the tissues just behind the level of the anus. It is carried across, well buried beneath the raw surface, to emerge at the opposite side at the same level. A second suture is passed at a distance of three-quarters of an inch in front, also buried beneath the surface. A third or a fourth suture may be passed, in like manner, as may be necessary (Fig. 70). The width of the raw surface averages about an inch. Unless the surface be thoroughly pared, so as to form a good thick cushion instead of only a thin cutaneous support, the tendency to prolapsus will continue; and any point of undenuded surface will probably be followed by the establishment of a fistulous opening. Hæmorrhage is often rather free, and the fissure should not be brought together until this has ceased. Ice is the best styptic. Division of the sphincter ani, on each side of the coccyx, was recommended by Mr. Baker Brown, in order that its action should be paralyzed and all tension of the part be overcome. This addition to the operation may be useful, when the laceration passes high up into the recto-vaginal septum. The parts having ceased to bleed, and coming freely together into *easy* apposition, the quilled sutures are applied at as many points as may be necessary to bring the surfaces into one line of union (Fig. 71). For this purpose, two pieces of bougie may be used; or two quills, rods of glass, or perforated metal or ivory bars. Fine whipcord is the best material for the sutures. By the thickness of the raw surfaces, and the firm support of the lateral rods, the superficial edges of the fissure are often seen to be everted. In concluding the operation, therefore, it may be advisable to bring the *edges* together with a few points of ordinary interrupted suture; using metallic wire in preference to fine silk. But some operators discard the quills, trusting to simple twisting. Mr. C. Brooke had the earliest successes with his bead-sutures.

After-treatment is very important. It consists in preventing any intestinal action for eight or nine days, by keeping the patient sufficiently under the influence of opium; and averting any dribbling of urine over the raw edges, by retaining a catheter in the bladder, furnished with a long india-rubber tube to carry off the urine free of the person. Scrupulous cleanliness of the parts is absolutely necessary. The strength must be maintained by abundant fluid nourishment. The sutures should not be removed for a week; and rest in the recumbent posture be still continued for two or three weeks longer, lest the recently united parts might yield.

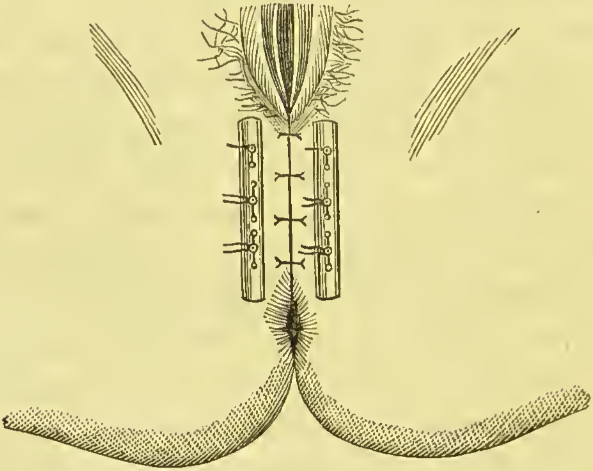

Fig. 71.

The prolonged recumbency incidental to this operation exerts a further beneficial influence in relieving the prolapsus. The turgid and ulcerated os uteri recovers a healthy state, and the relaxed uterine ligaments have time to regain their tension.

The *results* of this operation require further investigation. But the extent of laceration, and sometimes loss of substance, materially affect the issue. When the laceration involves the sphincter ani, and is consequently attended with incontinence of fæces, an operation for the restoration of the perineum will effectually afford the support necessary for control over defæcation. But the lesser evil consequence of such laceration—prolapsus—will be less certainly remedied. It may be cured temporarily, the prolapsus subsequently returning. *Failures* of the operation sometimes occur; more often as the result of extensive laceration, and perhaps loss of substance. If the patient's health is bad, or if erysipelas or other Hospital infection supervene, the wound may slough, and union be frustrated. Recto-vaginal fistula is an occasional result, principally from incompleteness of the operation itself. I have met with a complete failure only once; in the person of a very corpulent woman, the fat perineum rapidly became tense, and overspread with diffuse inflammation, followed by sphacelus, and a larger gap than before the operation.

URINARY-VAGINAL, AND UTERINE FISTULÆ.—Fistulous openings may be established: (1) between the urethra and vagina; (2) between the bladder and vagina; or (3) between the bladder and uterus. These communications result from contusions or laceration in parturition, the introduction of foreign bodies, the effects of calculous concretions in the bladder, or operations for their removal. Openings caused by the extension of cancerous ulceration are here omitted, as such fistulæ are quite incurable.

Much, and persevering attention has been given of late years to the Surgical treatment of the various forms of simple fistulæ; and results have been obtained in a large number of cases, sufficient to establish the operative cure of these distressing conditions as a finished achievement. We are chiefly indebted for this addition to Surgery, to the labours of Dieffenbach, Bozeman, Mr. Baker Brown, Dr. Marion Sims, Professor Simpson, Mr. Bryant, Sir Spencer Wells, and Dr. Emmett, of New York, whose clinical 'Treatise on Urinary Fistulæ' is the most valuable record with which I am acquainted.

The principal features connected with the operations as more recently practised, and which have led to their increasing success, are thus enumerated by Mr. Jonathan Hutchinson. Speaking chiefly of vesical fistulæ—1st, the use of chloroform, which facilitates the difficult step of the dissection; 2nd, the use of metal sutures instead of silk; 3rd, the avoidance of the vesical mucous membrane, both in the dissection and in the application of the sutures; and 4th, increased attention to keeping the bladder empty afterwards. It may be added, that metallic or wire shields, adjusted over the line of union, were much relied on a few years since; but they are now generally discarded in favour of sutures alone.

Vesico-vaginal fistula may be taken as the type of the three urinary fistulæ, relating to the vagina and uterus. The requisite operation consists in completely paring the edges of the vaginal aspect of the fistula, and then uniting them by suture. But many particulars should be observed, as tending materially to the success of this procedure; and they are tersely stated in the following summary by Hutchinson, which I can endorse by my own experience:—The instruments used are small tenotomy-like knives, forceps, needles, and fine silver-wire. Instruments for carrying the wire have also been devised; as Startin's tubular needle and adjuster. The patient should be in her best state of health, and the bowels have been well cleared out. Chloroform having been given, the woman is placed either on her side with the knees well drawn up, or in the usual lithotomy position. The parts being thoroughly exposed by a duck-bill speculum, and the nates being held widely apart by an assistant; the operator proceeds to drag the opening as low down as possible, with a view to facilitate the paring of the edges. This may be accomplished either by hooks, blunt or sharp; by means of a metal suture; or by the introduction of a flexible sound through the urethra, which is brought out again through the fistula, and then bent backwards. This latter plan furnishes the Surgeon with a most efficient hook, and one which cannot easily slip. In paring the edges, it is necessary thoroughly to denude every part; for if the smallest portion of mucous membrane be left, it may prevent union. None of the mucous membrane of the bladder must be removed. The wound should present a bevelled oblique line, slanting from a large vaginal opening to a smaller vesical one. The denudation being complete and free, sutures are next to be introduced.

These should be passed obliquely from at least a third of an inch outside the edge of the incision. They must not include the mucous membrane of the bladder. The tightening and tying of wire sutures may be accomplished by the fingers, but more effectually by means of the depressor as used in the operation for recto-vaginal fistula. Care must be taken not to pull them too tight, so as to evert the edge of the vaginal mucous membrane.

After-treatment is simple:—The small double-curved silver catheter invented by Dr. Sims, or an ordinary gum-elastic one, should be passed and retained unplugged; that the urine shall continuously drain out of the bladder. This should be constantly watched; and the instrument cleansed and then re-introduced twice a day. The patient must lie on her side with the knees drawn up; and her general health be well sustained. It is of the utmost consequence to prevent the action of the bowels for at least a week; and this may be accomplished by administering a full dose of opium soon after the operation, and maintaining its influence subsequently by smaller doses. Dr. Sims lays much stress on this point, as an element of success. The removal of the sutures prematurely is a greater evil than their unnecessary continuance; they should certainly not be withdrawn before the ninth or tenth day, and then with great caution. But with every care, the Surgeon who records his failures as well as his successes, will have to confess perhaps an adverse balance in the results of this operation.

Urethro-vaginal fistula is more easily closed by a similar procedure; but union takes place less readily, owing to the unavoidable pressure of the catheter on the line of union. This I have experienced in my own operations. It is better therefore to adopt the practice now I believe generally pursued; that of withdrawing the urine occasionally, by gently passing a catheter, or even to allow micturition, from time to time, without interference. Scrupulous cleanliness should of course be observed.

Vesico-uterine fistula is that condition wherein the fistulous communication exists between the bladder and cervix uteri. Certain modifications in the plan of operation will be required. It might become desirable to obliterate the upper part of the vagina, in order to connect the uterus with the bladder; thus allowing the menstrual fluid to pass through this organ, but preventing incontinence of urine.

These operative procedures may have to be repeated a second, or third time, and even several times, in the same case; partial closure only being effected in the first instance, and afterwards more and more completely. Such temporary failure, however, will not weary the perseverance of the true Surgeon, nor the endurance of the patient, who is too glad to get rid, even by degrees, of a most troublesome, offensive, and socially distressing urinary leakage. But, it not unfrequently happens that a pin-hole opening only, remains, defying any plastic procedure. In common with other Surgeons, I have had to contend with this difficult residue of the operation. No means of closing the aperture will, I believe, prove effective except the introduction of a red-hot wire, or better,—the galvanic-wire cautery.

CONGENITAL MALFORMATIONS OF THE ANUS AND RECTUM.—*Imperforate Rectum*, as a congenital malformation or deficiency, may exist in two primary conditions: imperforate anus; or, the anus leading into a cul-de-sac, imperforate rectum. The former condition—imperforate anus—presents five varieties: (1) simply membranous obstruction of the anus; (2) with partial or complete deficiency of the rectum; (3) communication with the neck of the *bladder* or the *urethra*, in the male; (4) communication with the vagina, in the female; (5) external communication, or fistula. The latter condition—imperforate rectum—presents two varieties: (1) membranous obstruction; (2) partial or complete deficiency of the rectum.

Signs.—When, after birth, there is no *evacuation*, during the first thirty-six or forty-eight hours, of the usual dark-coloured meconium fluid, and perhaps sickness co-existing, the medical attendant or the nurse is led to discover that the *anus* is *imperforate;* if indeed this deficiency had been overlooked at the time of birth. The condition of the rectum, when obstructed, is almost sure to be undiscovered at birth; but if *no bulging* in the fundament be perceived after some hours have elapsed—the anus being imperforate—the lower end of the *rectum* will probably be deficient also (Fig. 72). *Imperforate rectum* is distinguished by the presence of an anal cul-de-sac. The finger can sometimes be introduced into this sac to the extent of its depth—half an inch to an inch and a half. Those varieties of imperforate anus in which a *communication* exists with the bladder, the vagina, or externally, admit of less direct recognition during life. But the discharge of feculent fluid through the urethra, the vagina, or an external fistulous opening, will be severally diagnostic of these malformations. In the latter state, the situation of the opening varies in the two sexes. In the male, the fistulous opening may be in the perineum just behind the scrotum, in the scrotal raphé, or anterior to the scrotum. In the female, it occurs in the perineum close to the vagina, or at the posterior commissure of the vulva. In both sexes, and in all these situations—vesical, vaginal, and perineal—the vent is insufficient, and defæcation more or less difficult. Hence, constipation and intestinal dilatation ensues, especially as the fæces acquire consistency, and sooner or later life becomes endangered.

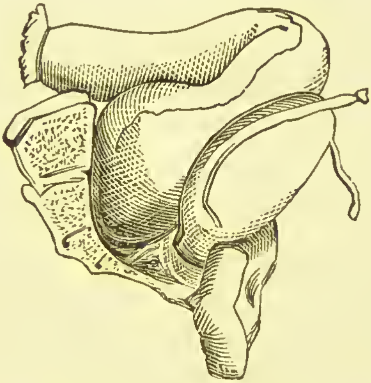

FIG. 72.—London Hosp. Mus., A. *e*. 78. Imperforate anus, and hypertrophied coccyx; in a child, three days after birth. Mr. McCarthy found that the coccyx reached nearly to the symphysis pubis; he removed a portion, but as there was no appearance of the rectum, colotomy was performed in the left inguinal region—the sigmoid flexure of the colon being opened. The child lived until the sixteenth day after the operation. P.-M. examination showed that the rectum terminates in a cul-de-sac above the recto-vesical fascia, and therefore out of reach for any safe operation.

All the foregoing malformations seem to occur more commonly in male children than in female. Thus, of 100 cases collected by Mr. Curling, 68 were males and 32 females. But of 100 cases recorded by M. Bouisson, 53 were females, and 47 males. So, therefore, the liability of sex is doubtful.

Treatment.—Operative interference is necessary or becomes necessary to preserve life, in consequence of the anal or rectal obstruction; or to remove a wretched and disgusting infirmity, in the cases of fistulous communication, vesical or vaginal, or of an external perineal opening. The principle of operation is to remove the obstruction by the formation of an anal opening in the situation of the natural anus—the establishment of an artificial anus in the natural situation; or by the enlargement of a fistulous communication at some distance off; substitute procedures being, an artificial anus in the left iliac region or the left lumbar region, respectively, by Littré's or Amussat's operation of colotomy.

Imperforate Anus, as a simply *membranous* obstruction, may be easily remedied. The integument over the seat of the termination of the rectum is usually so thin that the meconium can be distinguished by the dark-blue or black colour of the skin; and bulging becomes plainly visible when the child cries. A central crucial incision should be made with a sharp-pointed bistoury, and the four angles of the integument excised. The aperture must then be maintained by the introduction of an oiled tent or the passage of a bougie daily, until the anus is fully established, which seldom requires more than a week.

Deficiency of the rectum, coexisting with imperforate anus, should be managed on the same principle. An incision is made at the site of the anus, exactly in the middle line; and then the dissection must be prolonged cautiously towards the coccyx, extending to the depth of an inch and a quarter. The closed termination of the bowel may thus be reached, or in the course of a few hours it comes into view, being forced down by the infant's crying. When reached, the bowel must be opened freely with the bistoury, then drawn down to the external wound, and there attached by sutures. After this procedure, the same precaution will be requisite as before, in order to see that the anus shall become permanently established; a bougie should be passed occasionally for several weeks. In the event of a failure to reach the bowel, colotomy must be performed, in the left iliac region.

Imperforate rectum—the anus opening into a cul-de-sac—necessitates similar operative interference. By dilating the cul-de-sac with a sponge-tent, for a few hours, the seat of operation is rendered more perceptible. Then, on introducing the finger into the anal cul-de-sac, if the obstruction is membranous, the termination of the distended rectum can be distinctly felt as a thin septum under the point of the finger. This may be opened by an exploratory puncture with a grooved needle or fine trocar, and if meconium fluid or gas escape, a free aperture should be made with a sharp-pointed bistoury. If the distended end of the bowel cannot be felt, the anal cul-de-sac should be enlarged by an incision, carried towards the coccyx, so as to divide the posterior wall of the sac; and search made in this direction to the depth of an inch and a half or two inches from the anus. Having opened the bowel, above the occlusion, the mucous membrane must be drawn down to the skin and there attached with sutures. But the formation of an artificial anus, in this condition of imperforation, may be impracticable, owing to the depth of the bowel. A more simple method of operation—without dilatation or external incision, may, however, enable the Surgeon to reach the bowel without risk. In a case where the anal cul-de-sac was not larger than a small quill, I passed a director down to the extent of two inches, and distinctly felt the tense drum-head of the imperforate rectum; then, sliding a tenotomy knife to that point, a slight incision downwards and backwards, gave vent to the meconium fluid. Failing to reach the bowel, further operation should be abandoned, and colotomy, in the left iliac region, resorted to; or the deeper the imperforation, lumbar colotomy will be here more judicious, in order to be thus more certainly free of the occluded portion of rectum.

Rectal communications with the bladder, vagina, or perineum—co-existing with imperforate anus—may require operative interference, eventually, to preserve life, as constipation and intestinal dilatation supervene; and in any such case, interference will be justifiable to relieve and render tolerable the otherwise wretched state of existence.

In the case of a communication with the *bladder*, the opening is situated at the neck of the bladder, or more commonly at the anterior part of the prostatic portion of the urethra; it is not usually direct, but through the medium of a narrow channel, and is always small and insufficient. But the urethral aperture appears to be usually of a valvular character, so that, although fæces can pass into the urinary canal, the urine is unable to enter the rectum. The same operation should be performed as in the condition of imperforate anus coupled with deficiency of the rectum. Amussat, in 1835, first proposed that the end of the bowel should be brought down and secured to the integumental wound at the site of the anus; a proceeding much advocated by Dieffenbach. A passage lined with mucous membrane is thus made for the escape of the fæces, and the liability of feculent extravasation averted, and its consequences, diffuse cellulitis and peritonitis. Colotomy must be had recourse to, when the bowel is seated at a depth beyond an inch and a half to two inches.

Rectal communication with the *vagina*, or a fistulous opening in the *perineum*, may be remedied by either of two operative procedures—enlargement of the original outlet, or the formation of a new anus at the natural site, and closure of the abnormal anus.

Recto-*vaginal* communication has been cured in both ways. Enlargement of the original outlet, first suggested by Vicq-d'Azyr, is effected by division of the posterior wall of the vagina and the perineum as far as the coccyx, and retaining a canula in the bowel. A similar operation was performed by Dr. Barton, of Philadelphia, and another by Dr. Parish, of the same city. In one case, the infant was aged nine months; in the other, fifteen months. To establish a new passage at the natural site, a curved director or sound should be passed through the vaginal opening into the bowel, with its point directed to the site of the anus: this is then cut upon in the middle line, the incision being carried backwards towards the coccyx. A free opening having thus been made in the bowel, it is brought down and secured by sutures to the margin of the integumental wound. Dilatation must subsequently be maintained. Closure of the abnormal communication with the vagina may take place spontaneously; as in a case operated on by Dr. Sharpless, of Philadelphia, where the opening closed two months after the substitution of the operation-anus. Generally, it will be necessary to assist contraction and closure by touching the edges with the actual cautery; or, if the opening be large, the edges must be pared and brought together by sutures. After either procedure, the bowels should be kept at rest by opiates, for several days, until closure has taken place.

Recto-*perineal* communication, as the third variety of imperforate anus, has also been treated successfully by both modes of operation. Enlargement of the original outlet is performed by an incision towards the coccyx, and the application of sutures. The results of this procedure were quite satisfactory in two cases operated on by M. Goyrand; one a male infant, six months old, in whom, at the age of sixteen years, defæcation was free and the power of retention complete, even when the motions were lax; the other a female, aged eleven months. Equally satisfactory results have been obtained by Mr. Gowlland and by Mr. Curling, in a male and a female infant respectively. The formation of a new anus at the natural site has proved successful in the hands of M. Guillon and others. But enlargement of the original outlet will be preferable in all cases where the opening is sufficiently near the site of the natural anus; this is generally the condition in the female, and sometimes in the male. When, however, the opening is situated beneath the penis, or in the scrotal raphé, the other operative procedure must be resorted to.

The general *result* of unrelieved and long-continued rectal obstruction is well shown in a case of imperforate anus with the recto-vaginal fistula, operated on by Mr. Lane; the child being four and a half years old. The bowel was opened at the anus, and the septum between the two apertures was divided. Death ensued in twenty-three days. The continual strain upon the rectum had produced distension to a size almost incredible; the rectum and sigmoid flexure of the colon formed an immense reservoir capable of holding five pints of fluid, which occupied the pelvis, the hypogastric, both iliac, and part of the umbilical regions, displacing the viscera upwards and diminishing the cavity of the thorax.

CHAPTER VI.

URINARY DISEASES: DEPOSITS, AND CALCULI.

URINARY diseases are best introduced by observing the characters and composition of the urine in health, as the representative and exponent of blood-conditions in health.

HEALTHY URINE.

Physical Characters.—A fluid, clear, of a bright amber colour, peculiar aromatic odour, and specific gravity or weight, varying from 1·015 to 1·025, or perhaps 1·030, the average being 1·020; the quantity secreted varying from 40 to 50, or from 30 to 80, fluid ounces in twenty-four hours, the average being about 52 ounces. Slightly acid, except after food, when it becomes neutral or alkaline, during digestion in the stomach—chymification.

Chemical Composition or Constituents—qualitative and quantitative.—Mean or average in twenty-four hours, for the adult male:—

	Grains.
Urea	512·40
Uric acid	8·56
Phosphoric acid	48·80
Oxalic acid	1·42

		Grains.
	Brought forward .	571·18
	Sulphuric acid	31·11
	Hippuric acid	34·50
	Chlorine	126·76
	Extractives*	154·00
	Soda	125·37
	Potash	58·21
	Ammonia	8·58
	Lime	3·55
	Magnesia	3·09
	Iron	undetermined
	Mucus (adventitious)	7·00
Total	Solids	1123·35 Grains, weight.
	Water	52½ Ounces, measure.

In estimating the quantity of any urinary constituent excreted in twenty-four hours, the weight of the body and activity of the functions must both be compared therewith. Thus, the excretion of only 150 grains of urea, in a person whose weight is 80 lbs., would be a healthy proportion; but if the weight be 170 lbs., that quantity would be very disproportionate, and indicate a diseased condition of serious or fatal consequence.

The physiological origin of the urinary constituents is represented in the following tabular view, taken from Dr. Golding Bird's well-known work.†

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* *E.g.*, creatine and creatinine, and colouring matters.

† "Urinary Deposits," etc. Edited by Dr. Birkett.

1. *Organic Products.*

1st. Ingredients characteristic of the secretion produced by the destructive assimilation of tissues, and separated from the blood by the kidneys.	Urea, uric acid, creatine, creatinine, colouring and odorous principles.
2nd. Ingredients developed principally from the food during the process of assimilation.	In addition to the above, hippuric acid, lactic acid; accidental constituents.

2. *Inorganic Products.*

3rd. Saline combinations separated from the blood, and derived from the food.	Sulphates, phosphates, chloride of sodium, and all soluble salts taken with the food, and often undergoing decomposition in the system.
4th. Saline combinations chiefly generated during the process of destructive assimilation.	Sulphates. Phosphates.

3. *Ingredients derived from the Urinary Passages.*

5th. Mucus of the bladder.
6th. *Débris* of epithelium.
7th. Phosphate of lime.

Morbid conditions of the urine are—either increased or diminished proportions of its normal constituents, or new adventitious ingredients, those, perhaps, of most practical importance being sugar, albumen, and bile.

The urinary bladder can well tolerate the normal urinary constituents, *i.e.* healthy urine, which only sufficiently irritates that organ to suggest, from time to time, the evacuation of its contents, as the temporary receptacle of this excretion. But if either of the many constituents adverted to be secreted in excess, or if some new one be present, the bladder at once rejects the unaccustomed urine, the functional condition of excitement —irritability of the bladder, with, therefore, too frequent and painfully urgent micturition, is induced.

Morbid conditions of the urine are, in common with its healthy conditions, immediately referable to corresponding causative conditions of the *blood;* but their pathological *origin*—like the physiological origin—within the body is remote.

Morbid Conditions of the Blood.—In *health,* the composition of the blood is ever changing, by the addition of new matter, received through the process of digestion,—the primary assimilation of food, and as effete matter or waste of the textures, through their destruction in the course of nutrition,—secondary assimilation; and, furthermore, ever changing, by the abstraction of old, effete matter,—or excretion through the kidneys, skin, liver, and other excreting and secreting organs.

So likewise, in various *diseases,* the composition of the blood is ever changing, by the addition of new morbid matter, through primary *mal*-assimilation, or secondary *mal*-assimilation, or by the co-operation of both these perversions,—the former representing that of digestion, the latter that of nutrition; and, furthermore, ever changing, by the non-abstraction or retention of morbid matter,—*mal*-excretion through the kidneys, skin, liver, and other excreting and secreting organs.

These various internal sources of blood-disease may be here briefly traced, although not always attended with morbid conditions of urine.

(1) *Mal-assimilation* (*a*) *in Nutrition.*—This source of blood-disease was first investigated by Prout,* and afterwards, physiologically, by Liebig,† who designated the destructive stage of nutrition 'destructive metamorphosis' of tissues. Prout was inclined to believe that in all cases of secondary mal-assimilation, the *formative* and *destructive* stages of this process are both perverted in a greater or less degree.

The various kinds of textures, as chemically distinguished—the albuminous, the gelatinous, the oleaginous—may severally generate morbid conditions of the blood, by their *destructive* metamorphosis in secondary mal-assimilation.

Lithic Acid ($C_{10}H_4N_4O_6$).—Albuminous tissues undergo decomposition into lithic acid, rather than lithate of ammonia; and the blood being thence surcharged with this acid, represents the "gouty diathesis."

Urea ($C_2H_4N_2O_2$), in like manner, resulting from the normal destructive metamorphosis of highly nitrogenous tissue—*e.g.*, muscle—may possibly be produced in excess, by such transformation taking place too rapidly for excretion, by the urine, to eliminate it proportionately; or, again, the excess may possibly arise from uric acid by its oxidation, as urea can be thus formed artificially.

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* "Nature and Treatment of Stomach and Renal Diseases."

† "Animal Chemistry." Translated by Gregory.

Phosphoric Acid (PO_5).—Textures abounding in phosphoric acid, *i.e.*, the brain and nervous system, by their destructive metamorphosis in an over-active degree, induce the "phosphoric diathesis." The blood is surcharged with this acid, in combination with alkaline and earthy bases; forming, respectively, phosphates of soda, and those of lime and magnesia. The *deposition* of the *latter* in the urine, the only phosphates ever *deposited*, does not represent their total amount, but only the alkalescence of the urine, as explained under "phosphatic urine." One general law appears to govern the evolution of phosphoric acid and the formation of phosphates: they always follow nervous exhaustion, particularly that resulting from over-brain-work. Of this source, two excellent examples are given by Golding Bird, in the work referred to. One was the case of a well-known clergyman, who led a comparatively inactive life during the week, but who undertook the arduous duty of three services every Sunday. This gentleman was a tall thin person, of dark complexion, lustrous eyes, and almost phthisical aspect. He was the subject of constant dyspepsia. The urine passed on Saturday evening, as well as on Sunday morning, although repeatedly examined, was healthy, except in depositing urates, and being of high specific gravity. Before his Sunday duties were completed he almost invariably experienced extreme fatigue, and a painful aching sensation across the loins, in addition to the flatulence and epigastric uneasiness under which he constantly laboured. The urine voided before retiring to rest after the severe duties of the day, was almost constantly of a deep amber hue, high specific gravity, and deposited the triple phosphates in abundance. The urine of Monday would contain less of this salt, which generally disappeared on the following day, and once more reappeared on the following Sunday evening. This state of things was observed for several weeks, and it ultimately disappeared on the patient relaxing from his duties, and enjoying the amusement of travelling for a few weeks.

Oxalic Acid (HO,C_2O_3).—The gelatinous textures may possibly, according to Prout, by their destructive metamorphosis, be converted into oxalic acid, which, entering the blood, represents the "oxalic acid diathesis." Beneke's original observations tend to establish, among other conclusions, the increased production of oxalic acid from an impeded metamorphosis, in the conversion of oxalic acid by oxidation into carbonic acid. (See Oxaluria.)

Sulphuric acid (HO,SO_3), derived chiefly from the oxidation of the sulphur in the destructive metamorphosis of the albuminous tissues, will, therefore, be produced in excess by their too rapid and abundant transformation in this stage of secondary assimilation. The oxidation of cystine and taurine is another probable source.

Hippuric acid ($HO,C_{18}HNO_5$), a highly carbonaceous acid, may, perhaps, be produced in excess by the destructive metamorphosis of nitrogenous tissue.

Lactic acid ($HO,C_6H_5O_5$), in excess, may also have a similar origin; muscular tissue everywhere abounding in lactic acid.

Chloride of sodium ($NaCl$) and chloride of potassium (KCl), in excess, are, perhaps, produced by the destructive transformation of the tissues in general.

Sugar of the grape—glucose ($C_{12}H_{12}O_{12}$) in the blood—and thence the origin of diabetes mellitus, may possibly proceed from the gelatinous textures (Prout); but the liver-origin of the glucose from glucogen, as shown by Claude Bernard, is now the generally admitted source.

(*b*) *In the process of Digestion*, perversions of primary assimilation generate morbid conditions of the blood, similar to those which emanate from perversions in the course of nutrition.

The perversions in question are referred by Prout to the stomach, the duodenum, and the chyliferous system.

Lithic acid may be a product of the imperfect digestion of albuminous food in the stomach. Mal-assimilation in the duodenum generally results from that in the stomach, and that which takes place in the chyliferous system of vessels may form the pseudo-albuminous matter of scrofula.

Urea.—An excess of nitrogenous food will probably produce excess in the blood; a considerable increase taking place in the urine after such food.

From this triple source the blood becomes contaminated, unless the product of mal-assimilation in the stomach and duodenum is evacuated as fæcal, ill-digested food.

Phosphates.—An excess of phosphates in the blood will result from an undue proportion of *food* containing them. A vegetable diet has this effect, of which the experimental observations of Dr. Bence Jones* afford ample proof. Alkalies, taken continuously, favour the production of phosphates, by supplying the base with which phosphoric acid may combine.

Oxalic acid is occasionally introduced by particular kinds of food—*e.g.*, common rhubarb, sorrel, etc.; and then, if *hard* water, which contains lime, be drunk, oxalate of lime is formed in the blood. But this acid is more frequently generated by mal-assimilation of saccharine matters during the digestive process, as was first suggested by Prout. Beneke's observations would include azotised articles of food as the chief source of oxalic acid; an excess of these constituents retarding their metamorphosis by oxidation, which converts oxalic acid into carbonic acid, in the destructive changes of the textures. (See Oxaluria.)

Sulphuric acid, partly derived from the sulphates of the food, whether vegetable or animal, and from the oxidation of sulphur in its course through the body, may introduce or produce an excess, when either mode of food-origin is increased beyond the requirements of the system.

Hippuric acid, in excess, may arise from food itself too rich in carbon, *i.e.*, vegetable, as compared with animal food. Medicines containing benzoic acid have a similar effect, this acid being converted into hippuric acid during its passage through the system.

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* "Animal Chemistry," etc.

Lactic acid, in excess, may also have a food origin; sugar, or amylaceous matters, by their decomposition, producing lactic acid, and certain sour kinds of food, as sour milk, or cabbage, having already undergone such decomposition.

Chlorides of sodium and potassium are introduced in excess, by articles of food abounding in these salts, *e.g.*, salted provisions.

Sugar.—Prout first suggested the possibility of sugar being a product of the primary *mal*-assimilation of farinaceous matters, and thence the origin of diabetes mellitus. It is well known that starch and gum are converted into sugar by the action of acids, and equally indisputable that the stomach is prone to acidity in diabetes—a clinical fact which accords with the view advanced by the authority referred to. But the actual production of sugar during digestion in diabetes was established by M'Gregor.*

Claude Bernard has since apparently demonstrated the constant production of sugar, alike from azotised and unazotised matters, by the liver, in health, and therefore the probability that this organ is at least one source of sugar in diabetes, by over-activity of its function, in respect of sugar-production.

Certain it is that sugar abounds in the blood of diabetic patients, as shown by the analyses of Maitland and Ambrosiani.

Oleaginous matters are probably generated freely by primary mal-assimilation in persons who have a marked tendency to obesity, and thence the blood becomes surcharged with fat. This excess not being relieved by secondary assimilation, it accumulates in the body, encompassing and invading the textures interstitially, and, in the process of nutrition, usurping and occupying the place of their proper structural elements, it becomes apparently one mode of fatty degeneration—by the substitution of fat; yet the blood remains surcharged from its original source of continued production.

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* *Medical Gazette*, 1837.

All the foregoing conditions of urine have reference to those blood-diseases which result either from perversions of nutrition, or of the functions of the digestive organs, or from both; and which manifest themselves by these morbid states of the urinary excretion, they being in their turn signs of the existing blood-disease. The kidneys are merely the channels through which the noxious matter, whatever it be, is excreted from the blood.

(2) *Mal-excretion* (*a*) *through Kidneys.*—The kidneys are liable to undergo certain structural changes, whereby some one or more of the urinary constituents ordinarily excreted is retained in the blood, and thus adding a noxious matter thereto, gives rise to its own peculiar blood-disease. In any such case the morbid state of the urinary excretion is the sign of that structural change which the kidneys are undergoing or have already undergone. These organs, and the blood-disease induced, stand in the relation of cause and effect; while the peculiar state of the urine is the sign of the particular cause in operation. I allude chiefly to congestion of the

kidneys causing suppression of urine, and to their fatty or granular degeneration—Bright's disease, as originating a certain blood-disease by the retention of urea and excretion of albumen; the renal disease being manifested by corresponding changes in the urine secreted—viz., the absence or diminished proportion of urea and water, and the presence of albumen in variable quantity.

All these urinary changes are reflected in the blood. Analysis discovers a large accumulation of water—tending to dropsical effusions, the retention of urea, and a diminished proportion of albumen, together with a rapid decrease of the red particles of the blood. "I am acquainted," writes Sir Robert Christison, "with no natural disease, at least of a chronic nature, which so closely approaches hæmorrhage in its power of impoverishing the red particles of the blood."

No other very marked changes occur. Subjoined are the results of Franz Simon's observations as quoted by Dr. Owen Rees.*

	Water.	Blood Fibrine.	Corpuscles.	Solids of Serum.
Health . . .	775·7	3·8	137·1	83·4
Albuminuria .	808·3	3·9	133·9	54·8 (1)
	859·2	8·2	75·5	57·2 (2)
	855·5	4·5	42·7	97·3 (3)

(1) A man aged 55.—First stage of granulation, anasarca: urea in blood.

(2) A man aged 44.—First stage, more advanced than (1), anasarca, pneumonia: urea in blood.

(3) A man aged 23.—Advanced granulation, after scarlatina.

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* "Nature and Treatment of Diseases of the Kidney, connected with Albuminous Urine, Morbus Brightii."

(*b*) *Skin-Excretion.*—Turning to other excretions—considered with regard to the etiology of blood-diseases—the *sweat*, being complementary to the excretion of urine, comes next in order. While, however, much is known respecting the structure and functions of the sudoriparous glands, chiefly by the researches of Purkinje, Breschet, and Roussel de Vauzeme, little can be said specially respecting this glandular system in its causative relation to morbid conditions of the blood, thus affording another proof, if more be necessary, of the incompetency of Physiology to predetermine anything in Pathology. The latter must be founded on independent observation; and in respect of the sudoriparous glands, their pathology has not yet been separately investigated. *Arrest* of the function of these glands—checked perspiration—has hitherto been observed only in connection with febrile diseases; "but," remarks Sir Erasmus Wilson,* "it is probable that the perspiratory secretion, like that of other secerning glands, may be diminished and checked, as a consequence of inflammatory disorder of the sudoriparous glands themselves, independently of the rest of the organism. Dryness of the skin, occasionally met with, is owing to the absence of secretion by the sebiparous or sebaceous glands."

Arrest of the perspiratory secretion must obviously induce some morbid condition of the blood, by retention of the *excrementitious* matters which should be eliminated. Rheumatism is usually attributed to this cause, under the influence of exposure to wet and cold.

The perspiratory secretion of certain parts of the body

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* "Diseases of the Skin," ed. 4.

—*e.g.*, the axillæ and feet—is apparently specially excrementitious; and the sudden suppression of rank sweat therefrom has been followed by typhoid symptoms of the worst character, obviously due to retention of poisonous matter in the blood.

Certain constituents of the *urine* and *bile*—*e.g.*, lithic acid and bilin respectively—may be detected in the perspiration occasionally, and then the blood is assuredly poisoned. Besides, however, being *complementary* to other excreting organs, it would appear that the skin, in common with all such organs, eliminates *many other* matters, which are either of a poisonous nature, or, if innocent, have accumulated in excess; and which, in either case, had been taken into the circulation. The following substances have been detected in the sweat: Quinine, sulphur, mercury, iodine, iodide of potassium, assafœtida, garlic, saffron, olive oil, rhubarb, indigo, Prussian blue, and copper.* Suppressed elimination of these matters will cause morbid conditions of the blood, severally varying in importance with the particular matter retained. The perspiration has been known to undergo certain inexplicable alterations of *colour*, becoming blue, green, saffron, yellow, ruby, or black; and unless such changes are due to colouring matters only, they bespeak some more serious perversions of excretion, which, if checked, will inevitably be reflected in the blood.

The sweat sometimes becomes altered in another sense. Instead of being excrementitious, it may carry off some one or more of the *essential* constituents of the blood, which is thus robbed of what should be retained. For example, albumen has been found in the sweat in rheumatic fever, gastric, putrid, and hectic diseases, and on the approach of death.* Or, some essential constituent of the blood, and one that is also a normal constituent of the sweat, may be secreted in *excess*; affecting the blood's healthy composition and properties, by altering the *proportion* of its essential constituents. For example, an undue quantity of sweat is sometimes secreted in very hot weather, thereby draining off from the blood an excessive quantity of *water*. This disorder, known as idrosis, was witnessed by E. Wilson in several instances, during the burning August of 1856; and a similar condition was a prominent feature of the "sweating sickness" that occurred in England in the sixteenth century.

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* "General Pathology," Stark, p. 1127.—"Elements of Physiology and Therapeutics," Baumgärtner, p. 486.

Possibly idrosis should be regarded as an excessive secretion of more than water; that *all* the constituents of sweat—which, as a whole, is properly excrementitious —are simultaneously eliminated, only in *undue quantity*; nevertheless, the blood's composition becomes altered, relatively to the *proportion* of *other* excrementitious matters passing into the circulation. The *balance* of *effete* matters of various kinds, ever mingling in the blood, is disturbed; and whatever relatively preponderates will represent a blood-disease, enduring until such balance is readjusted by a compensatory discharge of other excretions of an opposite character. This view of idrosis, and its relation to the constitution of the blood, implies a pathological principle, well illustrated by the consequences of an excessive discharge of *other* excretions. Bilious flux, for example, as compared with a diminished proportion of urine excreted, gives rise to a constitutional disturbance, which, agreeably to the principle alluded to, is thus interpreted by Dr. C. J. B. Williams:* Urine contains a large proportion of azote; its excessive separation from the blood, therefore, leaves a comparative predominance of hydrogen and carbon in this fluid. Bile, again, abounds in hydrocarbon, and its copious removal, therefore, leaves a superfluity of azote. Accordingly, a flux of bile is either accompanied by a highly loaded state of the urine, or by fever, not subsiding until the urine becomes very copious, or deposits an abundant sediment. The most probable interpretation of this fact is, that excessive secretion of bile disorders the composition of the blood: so long as the kidneys rectify this disorder, by separating in greater abundance the solid contents of the urine, no fever results; but if the kidneys fail in their task, fever ensues and continues until they resume it; then a free secretion from them, and copious urinary deposit, is symptomatic that the fever is declining.

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* Op. cit., Wilson.

(c) *Liver-Excretion.*—Contrasting with the blood-disease consequent on *bilious flux*, an opposite state of the blood, signified by jaundice, is the offspring of a continued *deficient* elimination of bile from the system. This occurs in either of two ways: by some mechanical impediment to the free escape of bile through the ducts into the duodenum, or by the suppression of bile-secretion.

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* "Principles of Medicine," 1856, pp. 131, 132.

The structural conditions will be hereafter noticed in connection with the Symptoms and Treatment; but in either case jaundice arises.

MORBID CONDITIONS OF THE URINE.—*Urine for Examination.*—The diagnostic significance of any particular state of urine must obviously relate to its source or origin in the system. The *products* arising and accruing from mal-assimilation—whether by that of digestion (primarily) or of nutrition (secondarily)—and which appear in the urine, can be selected for examination by observing a very simple precaution with regard to the sample of urine.

Urine secreted at from three to six hours after a meal, represents the products of digestion; while that secreted several hours subsequently, when the urine from this source has run off, represents the products of nutrition in its destructive metamorphosis, or the *débris* of the textures. The latter may be called *urine of the blood;* and if examined in the morning before breakfast, after an interval of fasting from over-night, will be found to contain, unlike the *urine of digestion,* the waste of the textures. To make this observation complete, the bladder should be emptied over-night, to preclude any admixture of the urine then in the bladder with that which is secreted during the night. By this precaution, the products from these two sources of urine can be detected and distinguished, in most cases, with approximate certainty.

Changes in Urine from Decomposition, after Emission.—Stale Urine.—The changes which take place in the urine after emission, and as the result of decomposition must not be mistaken for those which represent morbid conditions.

Healthy urine may thus undergo departures from its ordinary slightly acid reaction, in two opposite directions; becoming *highly acid*, or turning to an *alkaline* condition.

(*a*) *Hyper-acidity, or Acid Urinary Fermentation* (Scherer).—This change consists in the generation of lactic acid and acetic acid; the mucus of the bladder acting apparently as a ferment on the urinary pigment. Like other fermentative processes, therefore, this one is prevented or arrested by alcohol or boiling, or by removing the ferment—vesical mucus—by filtration. The changes consequent on this production of acidity are, a precipitation of the amorphous urates, then of uric acid, and often of oxalate of lime. Simultaneously, confervoid vegetations—the mould or sugar fungus—are apt to appear. Acidity, increasing for some five or ten days, declines as putrefaction succeeds. An ammoniacal reaction and odour now supervene, with opacity of the urine from the development of myriads of minute linear particles—vibrios. The amorphous urate deposit has become changed into dark round masses of urate of ammonia, uric acid crystals are replaced by bright prisms of triple phosphate, and amorphous phosphate of lime sinks as an abundant sediment. The growth of confervoid vegetations is arrested with the change of reaction, and they perish as putrefaction is established. Exceptions to this order of change occur. Urines of low acidity or of low specific gravity do not undergo any marked increase of acidity; but they become ammoniacal in a day or two, or possibly in a few hours.

(*b*) *Alkalescence,* in exposed urine, results from the transformation of urea into carbonate of ammonia, and this change may be induced by contact with any decomposing matter, stale urine in particular.

(*c*) Certain *organic deposits,* as blood-corpuscles, renal epithelium, and uriniferous tubule-casts, are soon destroyed by an exposure of twelve or twenty-four hours, especially in urine of low specific gravity. But pus-corpuscles, scaly epithelium, and spermatozoa, retain their microscopical characters for a much longer period, even to an advanced state of urinary putrefaction.

Bearing in mind all these peculiarities of decomposed urine, the rule should be to examine any specimen of urine within a few hours after its emission.

Clinical Examination of the Urine.—From a practical point of view, an examination of the urine is a much more simple procedure than that whereby original investigations are conducted, as commonly detailed in works on Urinary Pathology, but which necessarily involves a minute knowledge of chemical analysis and of microscopic manipulation beyond the requirements of clinical practice, or the time at command of those who are so engaged.

The following *method of examination* indicates the order of procedure which will commonly be found sufficient; and the essential particulars to be *noted* respecting morbid conditions of the urine.

(1) *Physical Characters.*—Observe the colour, clearness or turbidity, any deposit or foreign body, odour, and specific gravity, as shown by the urinometer. Reaction —acid, alkaline, or neutral, as tested by a slip of blue

litmus paper, or yellow turmeric paper; the one becoming red when the urine is acid, the other brown when the urine is alkaline.

A deposit—observe its colour, admixture with, or separation from the urine, and whether floating on the surface as a pellicle, suspended as a cloud, or precipitated as a sediment, apparently amorphous or crystalline.

(2) *Chemical Tests*—(*a*) for Deposits. Effect of *heat.* —Pour a sample of the urine, with deposit, if present, into a test-tube, and over the flame of a spirit-lamp heat gradually to ebullition. Observe the disappearance of turbidity, as when a deposit of *lithates;* or the appearance of turbidity, as by a deposition of *phosphates.* Or the latter appearance may be the coagulation of *albumen.* Drop a few drops of *strong nitric acid* into the tube, and heat again; the one deposit, phosphates, entirely disappears, the other, albumen, becomes increased and consolidated.

Other tests for deposits: solubility in acetic acid, in liquor potassæ; insolubility in both acids and alkalies.

An approximate estimate of the whole quantity of lithic acid, or of phosphoric acid, excreted, beyond what is indicated by any deposit, should then be determined.

(*b*) For Foreign Constituents.—*Albumen,* note its absence or presence; and make an approximate calculation, from the quantity in a given measure of urine, of the whole quantity passed in twenty-four hours. *Sugar,* note its absence or presence; and similar approximate calculation of quantity. *Bile*, its absence or presence.

(3) *Microscopic Examination.—Crystals*, note the absence or presence in the urine, or in any deposit; their shape, or other characters. Note *blood*-corpuscles, *pus* and *mucus* corpuscles, *epithelial* cells, *uriniferous* tubule-casts, *spermatozoa*. Vegetable *parasitic* productions, or as engendered in decomposing or fermenting urine, *e.g.*, penicillium glaucum in non-saccharine urine; torulæ cerevisiæ, yeast-plant, in saccharine urine, when subjected to the fermentation test. Other foreign substances, *e.g.*, hairs, cotton fibres from the towel used in examination, sputa, starch-granules from admixture of food or tooth-powder, fæcal matter, particles of soot, sand, or dirt.

Appliances for Examination of Urine.—(1) *Chemical.* Certain simple chemical apparatus and tests will suffice for a clinical examination of the urine, and of its deposits.

The *apparatus* comprises—Urine glasses; a rather tall and deep receptacle suitable for immersion of the *urinometer* in taking the specific gravity of urine, and a glass graduated as a measure; test-tubes, in a half-dozen series, with stand, spirit-lamp, and well-corked bottle of methylated spirit, slips or slides of glass, drop-tubes, and glass stirring-rods.

The *tests* ordinarily required are—acids: nitric acid fort., acetic acid; and alkalies: liquor potassæ, liquor ammoniæ fort. *Special* tests: sulphate of copper solution, or blue hydrated oxide of copper, or yeast for sugar-testing; sulphuric acid for bile-testing.

(2) *Clinical Microscope.*—Beale's clinical pocket microscope is a very simple, portable, and inexpensive instrument.

Object-glasses required for Clinical Examination.—Whatever form of microscope be preferred, the object-glasses, for magnifying the object to be examined, are the most essential requisite. The qualities of an object-glass consist in its magnifying power and achromatic character, by clearly defining the object, without any encircling play of colours. The powers most commonly useful in medical practice are two—the *quarter of an inch* focus, magnifying about 200 diameters, and the *inch*, magnifying about 30 to 50 diameters.

Microscope Lamp.—For examining objects by artificial light at night, or otherwise in the absence of daylight, some kind of illuminating contrivance will be necessary. An ordinary French lamp, provided with a blue glass chimney, may be used, or that recommended by Dr. Lionel Beale, a small paraffine lamp, with a round wick, may be preferred. But in the absence of any such lamp, a short wax candle, giving a clear white light, steadied by a screen, supplies a ready contrivance which will generally suffice.

Lithic or Uric Acid ($C_{10}H_4N_4O_6$) *in Urine.*

Diseases associated:*

Increased with

Dyspepsia.
Gout.
Nephritis, acute.
Rheumatic fever.
Disease of liver.
Cirrhosis.
Jaundice.
Chronic diseases of stomach.
Enlargement of spleen ?
Ague.
Leucocythemia.
Pneumonia.
Phthisis pulmonalis, acute.
    Ditto chronic ?
Emphysema of lung.
  Ditto, with bronchitis.
Capillary bronchitis, acute.
Pleurisy.
Disease of heart.
Typhus fever.
Typhoid „
Scarlet „
Small-pox.
Eczema impetiginodes, acute.
Epilepsy ?

Diminished with

Anæmia and chlorosis.
Diabetes mellitus.
Nephritis, chronic.

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* "Diseases associated" with the various Morbid Conditions of the Urine are gathered from Dr. Hassall's elaborate work on the Urine.

General Symptoms.—They are those of gout, which may be taken as representing the lithic acid diathesis.

The premonitory symptoms refer to the digestive organs, more especially, but also to the heart, lungs, brain, and perhaps other viscera. Dyspepsia, denoted by heartburn, eructations, acidity of the saliva, inappetency, and nausea. The bowels, distended with flatus, are irregular; urgent diarrhœa alternating with constipation. Pains dart about the body, and, with general restlessness and peevishness, there is much depression of spirits and gloomy apprehensiveness. Palpitations and shortness of breath evince the sympathy of the thoracic organs; while headache, with a swimming sensation, and sometimes a feeling of explosive fulness, are the accompanying cerebral symptoms.

A *fit* of the gout is manifested by inflammation attacking the joints, and very commonly the first joint, or ball, of the great toe. Commencing usually when the person about to suffer has retired, and has, perhaps, enjoyed some hours of sleep, he is awoke with pain in one of the feet, affecting the ball of the great toe, or, it may be, the heel, instep, or ankle. Cold shivering generally takes place, succeeded by heat, as the pain—boring, grinding, and wrenching—fastens more and more firmly on the spot of its choice. "Place your joint in a vice," said a witty Frenchman, "and screw the instrument up until you can endure it no longer. That will represent rheumatism. Then give another twist, and you will somewhat realize gout." The skin over this part is acutely tender, red, tense, and shining, encircled by some swelling and by converging turgid veins. Much restlessness and excitement supervene. In vain the sufferer seeks to relieve himself of the weight of his bed-clothes upon the part inflamed, in vain he shifts his foot from place to place in search of a cool and easy position. The pain, remorseless, grapples yet more tightly. At length, in the course of twenty-four hours or so, it loosens its hold gradually, perhaps suddenly. The sleepless excitement also then subsides, and the victim enjoys some temporary repose. He wakes again to undergo punishment. The toe-screw is re-applied, it may be with a turn or two less; and daily a slighter punishment is inflicted, until at length the full penalty has been paid. Then the cuticle peels off the part, for gouty inflammation ends in resolution, it never terminates by the effusion of lymph, suppuration, or gangrene.

Sometimes having settled in the foot, it suddenly disappears, and migrates to the stomach—though this has been denied—to the heart or brain; *retrocedent* gout, as it is then called, being, unlike the retreat of an ordinary foe, an assault on the very fortress of life. Less perilous migrations occur; to the urethra, with a scalding discharge; to the testicle, a form of orchitis; to the eye, inducing ophthalmia.

The real decline of an attack is marked and measured by a flow of urine, surcharged with lithic acid, thus relieving its accumulation in the blood, and plainly declaring the nature of the disease. Irritability of the bladder at this time is often tormenting. Repeated attacks of gouty inflammation leave structural results behind; the cellular texture around a joint becomes pervaded with a deposit of lithate of soda, forming concretions, at first pultaceous, then chalk-stones of perhaps considerable size. Hence the nodular toes and fingers of *chronic* gout. The skin over these nodules being stretched, at length breaks, and the chalky concretions are laid bare. Lithate of soda has been found infiltrating all the textures of one or several joints; in the synovial membrane, cartilage, heads of bone, and ligaments; and usurping their place, the articulations are irreparably destroyed.

Physical Characters of Urine.—Clear, bright, golden or coppery colour, like brown sherry. Specific gravity increased. Quantity somewhat diminished. Acid reaction more decided, producing a deeper shade of red in blue litmus paper. A deposit of *yellow* or *red sand*, resembling particles of cayenne pepper—lithic acid, sometimes in great abundance.

Diagnostic Value.—Lithic acid is eliminated from the blood, in combination with some base—soda, or ammonia more commonly, forming lithates of soda and ammonia. These salts, readily soluble in urine of the temperature of the body, are precipitated only when present in excess proportionately to the aqueous portion of urine secreted, and as the supersaturated solution cools. They then appear as yellowish, or red brick-dust deposits, which will be presently described. Lithic acid may, however, be liberated from these salts, by decomposition; but it occurs only when *some other* acid is present in *excess* to replace the acid in combination. Free lithic acid being insoluble, is then precipitated, appearing as a deposit in the urine having the above characters. This taking place readily as the urine cools, is apt to occur also within the bladder, and thence the commencement of gravel, or the formation of a calculus. Perchance, the same deposit in the pelvis of the kidney gives rise to a renal calculus, which subsequently descending, becomes a stone in the bladder; or the uriniferous tubules, and intertubular tissue of the kidney, get clogged up with uric acid, and urates, thus slowly obliterating the secreting substance, and resulting in one of the worst forms of chronic Bright's disease.

Microscopical Characters.—This deposit consists of minute crystals, in various shapes, of which rhomboidal prisms are the most commonly characteristic (Fig. 73).

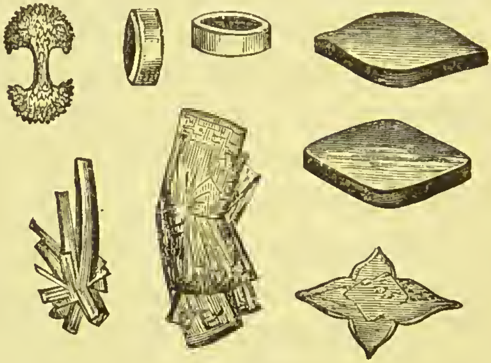

Fig. 73.

Respecting the kind of acid by which uric acid is thus deposited, Parkes observes:* "It does not follow that the acidity should be owing to any single acid; it is owing either to an augmentation of all the usual acids of the urine—the sulphuric, phosphoric, and perhaps the hippuric, the lactic, and the carbonic—so that the bases are insufficient to neutralize them—or to the formation of acids after emission of the urine—viz., probably the lactic, acetic, butyric, or oxalic.

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* "Composition of the Urine, in Health and Disease, and under the Action of Remedies," p. 218.

"It is, of course, possible that the deposit of uric acid may be owing, not to excess of other acids, but to absolute deficiency of alkali; no facts have yet been discovered on this point.

"The two causes of increased acidity of the urine—excess of normal acids, and formation of acid after emission—are sometimes in simultaneous action. The urine depositing lithic acid without lithates is not usually the high-coloured, red, pigment-loaded urine, but yellow and transparent; the acid is deposited slowly, and without admixture with lithates. Uroxanthin (indican) is often present in large quantity; and, as Virchow suggests, it may more rapidly form acid than common pigment."

The practical issue of all these considerations is this—that to rightly estimate the value of "lithic acid urine," as the sign of a corresponding "morbid blood-condition," it is necessary to discover the *total* amount of lithic acid excreted from time to time; and for this purpose we cannot trust any *deposit* thereof, either combined or free. The lithates may be in excess, *short* of a supersaturated solution; and lithic acid itself becomes apparent only when the urine is hyperacid from *other* causes.

Chemical Tests.—The over-acid reaction, as shown by blue litmus-paper, has already been noticed.

A *deposit* of uric acid is insoluble in hot water, but soluble in alkalies—potash, soda, and ammonia.

A portion of the deposit is to be dissolved in a drop of potash. The alkaline solution is then to be treated with excess of acetic acid. In a few hours, crystals of uric acid will have formed, which can be identified by microscopic examination.

A portion of the deposit may be placed on a glass slide, and treated with a drop of strong nitric acid. Evaporate to dryness by a gentle heat, and expose the slide to the vapour of ammonia, or add a drop. A beautiful violet colour, from the formation of murexide, attests the presence of uric acid, or a urate. (L. Beale.)

The *total amount* of lithic acid excreted can be discovered by a simple experiment, devised by Golding Bird. Let all the urine passed in twenty-four hours be collected, well shaken, and a given quantity—say about two ounces—be mixed in a conical glass vessel, with about half a drachm of hydrochloric acid. In six or eight hours crystals of uric acid are copiously deposited on the sides of the glass. To ensure their complete separation, they should be allowed to repose for twenty-four hours, and may then be washed, dried, and weighed.* Simple multiplication shows the whole amount of uric acid secreted in the twenty-four hours, without the chance of any considerable error. In estimating the pathological importance of the result thus obtained the healthy standard of quantity should be remembered, and this ranges from 6 to 10 grains of uric acid in twenty-four hours.

Urates or Lithates of Ammonia or of Soda in Urine.

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* "Urinary Deposits," ed. 4. See also "Animal Chemistry," etc., by Bence Jones, p. 53.

Diseases associated:

The same diseases as with Lithic Acid Urine.

Physical Characters of Urine.—Turbid in all cases on cooling, and depositing lithates; the other characters of the urine vary, principally, with their colour. *White* lithates are deposited from a pale-coloured urine; specific gravity low; 1·010 to 1·014. The deposit is suspended, having a whitish flocculent cloudy appearance, which resembles mucus. This almost colourless urate deposit occurs more especially in connection with dyspeptic derangement of the digestive organs. *Fawn*-coloured lithates are deposited from an amber-coloured urine; specific gravity higher, but still lower than normal, being about 1·018. Urate deposit of this light tint may occur independently of any morbid condition, but simply owing to concentration of the urine from profuse perspiration, as after violent exercise, or prolonged fasting, especially abstinence from drink. *Red* brick-dust lithates are deposited from a yet deeper-coloured urine, and of higher specific gravity. Such deposits betoken some febrile state of the system. *Purple* and *pink* lithates are deposited from a corresponding coloured urine, and of high specific gravity. These variously coloured appearances of lithates are due to the pigments of the urine, for which they have an intense affinity, and are thence precipitated in combination with the deposit. The chief ingredient in any such deposit is lithate of ammonia; the soda-lithate appearing more often in the urine from gout, or during the febrile complaints of childhood, and perhaps thus predisposing to the frequency of vesical calculus at an early period of life. The quantity of lithates secreted, and precipitated spontaneously, may not be equal. Hence the latter may not indicate the *whole* quantity. They are held in solution by urine of the ordinary temperature of the body, 98°; but as the urine cools on exposure in the vessel used for its reception, the lithates are deposited. The proportion of water, as a constituent of urine, will also regulate the quantity deposited. These two conditions have been already noticed. But over-acidity of urine, owing to other acids in excess, allows an abundant deposit; whereas a slightly acid or alkaline urine holds a proportion of the lithates in solution; and the presence of lithate deposit affords no sure indication of hyperacidity of the urine from lithic acid, in particular.

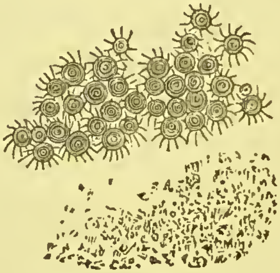

FIG. 74.

Microscopical Characters.—Amorphous granules is the usual appearance of lithate of ammonia, as seen under the microscope (Fig. 74), but certain forms of crystal are, occasionally, presented. Thus, spherules sometimes constricted in the middle, assuming a dumb-bell shape; or spherules with little claw-like projections (Fig. 74). Urate of soda exhibits a somewhat similar form. Acicular forms of urate of soda consist of needles detached, or having a radiated, stellate arrangement.

These forms are never found in urine as a spontaneous deposit; but with the addition of soda solution, the amorphous lithate of ammonia readily yields them, on evaporation. The acicular urate constitutes the white mortar-like or chalky matter, which forms the nodules in the fingers and toes of a person subject to chronic gout, or the concretions — tophi — which appear in the cartilages of the ears. The junction of lithic-acid crystals gives rise to various singular appearances.

Chemical Tests.—Heat re-dissolves the lithates. Hot, not to say boiling, water poured into the chamber-utensil, causes the turbidity to disappear, and thus clears the urine. But this result may be partly due to the increased proportion of solvent—water—thus added to a previously concentrated urine. A small quantity of the turbid urine heated in a test-tube becomes clear, but it again becomes turbid on cooling. The deeper-coloured urates are dissolved by a rather higher temperature than the paler varieties. Alkalies—potash or ammonia, dissolve these deposits; acids—hydrochloric or acetic, separate uric acid, having the appearance and crystalline forms already described.

A rough approximate analysis of the urates may be readily accomplished. The uric acid having been determined in a weighed portion of the dried urate by dilute hydrochloric acid, another portion of the urate should be burnt, and, after washing the ash, tested with the blow-pipe. If the base be ammonia, a very small quantity of ash only will remain. For a full analysis of the urates, they should be previously examined with the microscope to ascertain whether they are free from phosphate of lime or magnesia, or oxalate of lime. (Hassall.)

Potash may be the most abundant base, next ammonia, and last soda (Bence Jones). *Lime* is always present in considerable quantity (Hassall and Scherer). *Magnesia* is an occasional base (Robin and Verdeil).

It would, therefore, appear that the term *mixed* urates more accurately designates this deposit. The proportion of uric acid is always large—over 80 per cent. (Scherer); over 90 per cent. (Bence Jones).

Urea ($C_2H_4N_2O_2$) *in Urine.*

Diseases associated:

Increased with	Diminished with
Acute pneumonia.	Epilepsy.
„ phthisis.	Acute yellow atrophy of liver.
„ capillary bronchitis.	Spasmodic asthma.
Pleurisy.	
Acute hepatitis.	Non-febrile icterus.
Rheumatic fever.	Acute gout.
Meningitis.	
Typhus fever.	
Typhoid „	
Scarlet „	
Measles.	
Smallpox.	
Diabetes mellitus.	Diabetes insipidus.
Diuresis after dropsy.	

Increased with	Diminished with
Nephritis, acute.	Nephritis, acute and chronic.
Ague, during fit.	Ague, after fit.
Acute eczema ?	

General Symptoms—are those of great muscular weakness and nervous exhaustion, with sometimes a dull aching pain across the loins; a worn, anxious expression; and, with diuresis, pallid emaciation, craving hunger and thirst. Irritability of the bladder is a marked symptom in all cases.

Physical Characters of Urine.—Excess of urea may occur, without diuresis—the quantity of urine seldom exceeding the normal quantity, but the quantity of urea being both absolutely and relatively greater than in health; or with diuresis—the quantity of urine being excessive, and the quantity of urea, therefore, in a given specimen, less than in health, but the quantity, absolutely, and relatively to the other constituents, greater also, in this case, than normal. *Azoturia,* or unreal diabetes, as the latter may be termed, although differing only in degree, is a very rare disease.

The former condition of urine is, in colour, clear and pale, but occasionally assuming the appearance of porter diluted with water; odour, not peculiar, but ammoniacal (apparently from decomposition of the urea) when not quite fresh; specific gravity rather above the average, 1·020, but varying from 1·015 to 1·030, or even higher. Quantity about normal. Reaction acid, when the urine is fresh, but speedily becomes alkaline, from ammonia. A deposit of urea, in crystals, soon forms by evaporation, on the addition of nitric acid, forming the nitrate of urea.

Microscopical Characters.—Long needle-shaped crystals, by evaporating a drop or two of urine on a slip of glass. Nitrate and oxalate of urea also present crystals; the former in hexagonal plates and rhombic octohedra (Fig. 75); the latter, in rectangular and right rhombic prisms with a tendency to the formation of dumb-bell shaped oxalate of urea.

Chemical Tests.—Urea is never deposited spontaneously. Nitric acid added to a few drops of urine on a slip of glass, forms the nitrate of urea ($C_2H_4N_2O_2,HO,NO_5$), which, on evaporation, appears as a crust, more or less thick, according to the *quantity* of urea. Oxalate of urea ($C_2H_4N_2O_2,HO,C_2O_3$) is formed in like manner. Either compound can be verified by microscopical examination, while the chemical test indicates, approximately the *quantity* of urea present.

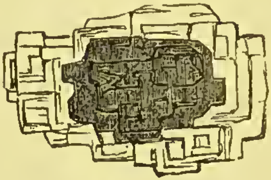

FIG. 75.

Other tests are described in special works, but the above is the most ready method of detecting and determining urea.

The separation of urea, in a free state, may be obtained from either the nitrate or oxalate, by the following simple process: Dissolve the oxalate of urea, for example, in hot water, and treat the solution with carbonate of lime, until effervescence ceases; the oxalate of lime thus formed and any excess of the carbonate are precipitated, leaving the urea in solution. Carbonate of baryta may be used instead of the lime salt. Nitrate of urea may be decomposed in like manner. Crystals of nitrate of baryta are thrown down; the fluid is to be filtered, evaporated, and the residue extracted with ether.

Distinctive Characters of Urate of Soda, Earthy Phosphate, and Pus.—These three deposits are very similar in appearance, but have widely different pathological significance. Their certain and easy distinction is therefore of great practical importance. The following simple method of examination, and distinctive characters, are given by Dr. Lionel Beale.

Let the urine stand in a conical glass for some time. Then pour off the clear supernatant fluid, and transfer a small portion of the deposit into a test-tube. Add about half the bulk of solution of potash, and observe:

1. If urate of soda and ammonia, the potash may cause the mixture to become *clear*, but not viscid.
2. If entirely phosphate, *no change* will be produced.
3. If pus deposit, the mixture will become *clear*, and very *stringy* or viscid.
4. If both pus and phosphate be present, the mixture gelatinizes, but does not become clear.

Microscopic examination will confirm this chemical test.

Phosphates in Urine.

Amorphous phosphate of lime—bone-earth ($3CaO,PO_5$).

Crystallized phosphate of lime ($2CaO,HO,PO_5+3HO$).

Phosphate of ammonia and magnesia—triple phosphate ($NH_4O,2MgO,PO_5+12HO$).

Phosphate of soda ($2NaO,HO,PO_5+24HO$).

Acid phosphate of soda ($NaO,2HO,PO_5+2HO$).

Diseases associated :

Increased with	Diminished with
Meningitis.	Delirium tremens.
Acute mania, during parox.	Acute mania, in exhaustion.
Acute dementia, during paroxysm.	Acute dementia, in exhaustion.
Rickets.	Paralysis of insane, third stage.
Mollities ossium.	Acute gout.
Acute rheumatism.	Acute rheumatism.
Cholera early.	Cholera later.
Chronic phthisis ?	Pneumonia.
	Bright's disease, acute and chronic.
	Typhus abdominalis.
	Pleurisy, acute ?
	Ague ?
	Diabetes ?

General Symptoms—consequent on an excess of phosphoric acid in the system, are those of exhaustion with irritability. Depression of spirits with irritability of temper ; muscular weakness, and aching pains, especially across the loins, with perhaps a flickering endeavour to shake off debility, for such persons are not unfrequently intellectually active and energetic beyond their strength ; these symptoms, with atonic flatulent dyspepsia, and sallow emaciation, as if consumption were in progress, complete the picture of the phosphoric diathesis. Irritability of the bladder is frequently very distressing.

Physical Characters of Urine.—Turbid in all cases, on depositing phosphates; of a pale yellow colour, if the deposition be occasioned by fixed akali—potash or soda; and of an orange-brown colour, if occasioned by carbonate of ammonia—volatile alkali. The odour is ammoniacal, in the latter case; while the specific gravity varies greatly with the colour—the pale urine having a low specific gravity, the higher-coloured a high specific gravity. The quantity is increased generally. The reaction varies—being alkaline or neutral, or slightly acid when first evacuated. The deposit of phosphates appears as a *white sand;* but generally combined with mucus, often present in large quantity, and pus, probably in variable quantity, when the urine is ammoniacal, and the surface of such urine is often covered with an iridescent crystalline pellicle.

Diagnostic Value.—Phosphatic urine, as ordinarily estimated by the amount of phosphates *deposited* in the urine, is deceptive. Phosphatic urine, in this sense, is only an appearance, not a true measure of the whole amount of phosphates present, and of the pre-existing blood-condition.

The pathological significance of phosphatic deposits in the urine has been investigated more particularly by Dr. Bence Jones.

Of *all* the phosphates *present,* not necessarily deposited, in the urine, those of soda are most abundant; equalling in amount three or four parts of the whole. The earthy phosphates of lime and magnesia represent the remainder. Phosphatic urine, therefore, should rather, of the two, have reference to the former salts. But the phosphates of soda are so very soluble in water and in acid or alkaline urine, that they are never deposited. In this respect resembling the sulphates of potash or soda, any excess of these phosphates remains concealed. On the contrary, the phosphates of lime and magnesia are scarcely soluble in water, and nearly insoluble in alkalies, although very soluble in acids, even in acid phosphate of soda. Therefore, whenever the urine becomes alkaline, down go the phosphates of lime and magnesia. This precipitate, however, denotes only the quantity of lime and magnesia drawn from the blood, and now appearing in the urine. The *major* portion of *phosphoric acid*, being combined with soda, remains unobserved.

By taking more lime or magnesia in the food, or by adding these bases to the urine, we increase the amount of earthy phosphates; and by a sufficiency, we precipitate *all* the phosphoric acid in combination with *them*, thus leaving no *phosphate* of soda in solution. Conversely, if we could abstract all the lime and magnesia, no precipitate would appear by adding alkalies—in which, as well as acids, phosphate of soda is soluble,—though there remained a great excess of phosphate of soda concealed in solution. But if lime and magnesia are present, as usual, in the urine, a portion of the phosphoric acid appears in combination with them, forming a deposit of *these* phosphatic salts whenever the urine becomes *alkaline*, in which they are insoluble. Hence the more appropriate name, *alkaline* urine, suggested by Dr. Bence

Jones, rather than phosphatic urine, as ordinarily understood, which represents merely the amount of lime and magnesia present in combination with phosphoric acid. If regarded from this latter point of view, the term "phosphoric diathesis" should be extended to denote an increase in the *total* amount of phosphates, *alkaline* and earthy; or, if limited to one phosphate, it ought to denote *alkaline* phosphate, that being proportionately four or five times more abundant than earthy phosphates in the urine; moreover, the term "earthy diathesis," as indicated by the urine, if used at all, ought to signify urine which really contains an *excess* of lime and magnesia, and not the precipitation, it may be of only a small quantity, of these earthy salts, the urine having lost its healthy property of retaining them in solution on becoming alkaline.

In short, alkalescence of the urine and increase in the *total* amount of phosphates have no relation of any kind to each other. They are quite distinct, and, indeed, rather opposite states.

Microscopical Characters.—Supposing *alkalinity* of the urine be due to *fixed* alkali—as potash or soda—the phosphate of lime and the phosphate of magnesia are immediately deposited, appearing as a "white sand," which might be mistaken for pale lithates. Submitted to microscopic examination these salts are seen to consist of amorphous particles, or small round globules, and, occasionally only, prismatic crystals, with oblique or dihedral summits (Fig. 76). According to Hassall's observations,* crystallized phosphate of lime is common, much more so indeed than amorphous phosphate, which he regards as unusual.

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* *Lancet*, 850, vol. i.; and "Med. Chir. Trans.," vol. xxxvi.

This white deposit and co-existing alkaline condition of the urine occur whenever an excess of fixed alkali, or, what is equivalent, a deficient proportion of acid, is taken in the food. The urine is *secreted* alkaline, and deposits its earthy phosphates in greater or less abundance, according to the quantity of lime and magnesia present.

Not to be misled by an alkaline condition of the urine from *fixed* alkali, it is most important to know and remember that the acidity of *healthy* urine varies considerably during the diurnal period. According to the observations of Dr. Bence Jones, confirmed by those of Dr. W. Roberts, it is *inversely* to the acidity of the stomach. During digestion, when some acid, probably the hydrochloric, is being secreted by the stomach, an equivalent amount of soda or potash, previously in combination, must remain as free alkali in the blood, rendering it proportionately more and more alkaline. Accordingly, the urine becomes less and less acid, and perhaps eventually decidedly alkaline. When acid ceases to flow into the stomach, and any superfluous portion which had been secreted is reabsorbed, the blood regains its former *average* degree of alkalescence; the urine also is secreted less and less alkalescent, and becoming acid, its acidity arises until the next meal, when the highest degree of acidity is attained. If no food be taken, this condition of urine remains stationary for about twelve hours; immediately after a meal, its acidity again falls, and gradually approaches an alkaline reaction.* Then the amorphous phosphates may be deposited, especially if the urine becomes more alkaline, by the ingestion of carbonates, acetates, or citrates of alkalies in various fruits. The urine is passed in a turbid state, and this turbidity rather diminishes as the urine cools, the fluid becoming somewhat clearer. Examined in the interval of digestion, alkalinity of urine might inadvertently be regarded as a morbid condition; but examination of another and another sample excreted some time after a meal, when the process of digestion is completed, corrects this suspicion; the urine thenceforth is found more and more acid prior to the next meal, when the alkaline retrogression supervenes.

This alternation of an alkalescent state of the urine during digestion, and restoration of acidity on completion of digestion, invalidates the result of *any one* examination of the urine. A *mixed* sample of the whole amount of urine excreted during the twenty-four hours will give its average condition.

If *volatile* alkali—as carbonate of ammonia—be the occasion of alkaline urine, then the *deposit* consists of the ammoniaco-magnesian phosphate—triple phosphate—together with some phosphate of lime; the former appearing in the form of transparent prismatic crystals, or of foliaceous, stellar, or penniform crystals (Fig. 76). The two latter are phosphate of lime.†

This deposit occurs whenever phosphates are deposited in connection with an inflamed state of the mucous membrane of the bladder, the ammonia being supplied by the decomposition of urea, which constituent of the urine may be regarded as carbonate of ammonia, plus two atoms of water. Whether urine is ever *secreted* ammoniacal appears doubtful; without doubt, however, it may become so, after emission, by decomposition of the urea. This source of the ammonia present in the phosphate, as then formed, was first clearly perceived by Lecanu, and has since been explicitly pointed out by Owen Rees. The decomposition of urea is effected apparently by the mucus, acting as a ferment, which is always more freely secreted by an inflamed mucous membrane, as in pyelitis and cystitis. Ammoniaco-magnesian phosphate, consisting of its characteristic crystals, is abundantly deposited; and equally so, a white tenacious substance, that can be drawn into skeins of considerable length. It is said to consist of pus-globules, they having become adherent under the action of ammoniacal urine. The phosphate above mentioned, together with granules of phosphate of lime, are thus involved in one gelatinous mass; forming perhaps a calculous concretion in the bladder, and presenting an iridescent pellicle on the surface of such urine, when passed. This

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* See adverse observations by Dr. Julius Vogel: "A Guide to the Analysis of the Urine," by C. Neubauer and J. Vogel, ed. 4. Translated for New Syd. Soc. by W. A. Markham, p. 296.

† *Lancet*, 1853, Hassall.

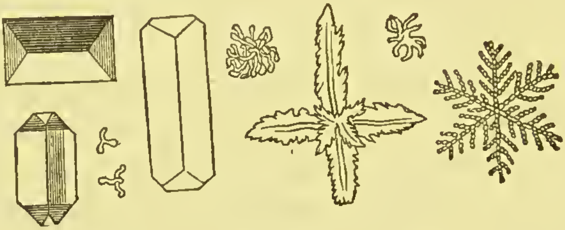

Fig. 76.

mixed deposit is frequently witnessed in cases of paralysis affecting the bladder, a condition bordering on chronic inflammation.

But the unmixed ammoniaco-magnesian phosphate deposit may occur occasionally in urine which is not perceptibly ammoniacal.

Chemical Tests.—All the phosphates are dissolved by acids—unlike coagulated albumen; and remain unaffected by heat, or the urine becomes even more turbid on boiling—unlike the deposit or the turbid urine of the lithates; but the following points of contrast distinguish the two kinds of alkaline urine—the ammoniacal from that caused by fixed alkali.

Ammoniacal urine effects no change in blue litmus-paper until it dries, when the pink colour immediately appears.* Urine becoming alkaline during digestion, *i.e.*, from *fixed* alkali, turns pink paper blue, which remains so when dry. *Ammoniacal* urine deposits crystals of phosphate of ammonia and magnesia, while urine otherwise alkaline, from *fixed* alkali, deposits an amorphous powder of phosphate of lime. The former deposit is associated with mucus and pus; the latter with mucus only, and rarely in great quantity. *Ammoniacal* urine is constantly alkaline; that from fixed alkali is only occasionally alkaline, *i.e.*, at particular periods of the day. *Ammoniacal* urine is a sign of local disease—inflammation of the urinary mucous membrane; whereas alkalescence from *fixed* alkali is a sign of a more general disorder, *i.e.*, indigestion.

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* See "Trans. of the Chemical Society," vol. ii. p. 244, communication by Bence Jones.

Guided by these characters, we can detect and discriminate the *kind* of alkali present in the urine, and its *source.* Yet such diagnosis, founded on the kind, and even the amount, of phosphatic salts *deposited* by the urine, signifies nothing concerning the *total* amount of phosphates *excreted from the blood.* The non-appearance of phosphates does not imply their absence, and their appearance is no measure of the total amount present. Should the urine be alkaline, we then discover merely the amount of earthy bases—lime and magnesia, excreted in combination with phosphoric acid, and deposited. But this deposit of phosphoric salts contains only part of the whole phosphoric acid present. By far the greater portion remains concealed in the soluble phosphate of soda, which is never spontaneously precipitated under any circumstances.

The term "phosphatic diathesis," as formerly used by Dr. Prout, is now abandoned. It signified only alkaline urine.

To determine the *whole amount* of phosphoric acid eliminated, it is necessary to ascertain the amount of this alkaline phosphate, as well as that of the earthy phosphates. Both together represent the *phosphoric* diathesis.

For this purpose the following experimental process is recommended by Bence Jones:—About 1000 grains of urine are to be weighed, and the earthy phosphates precipitated by pure ammonia, free from carbonate. These should be filtered, washed with ammoniacal water, and heated to redness; adding at last a drop or two of nitric acid. The amount of earthy phosphates is determined by weighing the residue. The alkaline phosphates are estimated by taking about 500 grains of urine, adding an excess of chloride of calcium, and then pure ammonia. Thus all the phosphoric acid is precipitated as phosphate of lime. This is to be filtered, well washed, and the filter and the precipitate burnt with a drop or two of nitric acid. If the filtration has been slow, it is necessary to re-dissolve the residue in a platinum crucible by hydrochloric acid, and to re-precipitate by pure ammonia, when the filtration will take place very rapidly. After being burnt, the crucible is weighed, and by deducting the previously determined earthy phosphates, the difference may be taken as the amount of alkaline phosphate.*

Oxalate of Lime ($C_2O_3+CaO+2HO$) *in Urine.—Oxaluria.*

Diseases associated:

Increased with

Dyspepsia.
Gouty diathesis.
Uric acid and urates in urine.
Cirrhosis of liver.
Jaundice.
Cholera, convalescence.
Bright's disease, chronic.
Convalescence from severe diseases.
Many chronic diseases.

Scrofula.
Rickets.
Emphysema of lung.
Emphysema of lung with phthisis.
Emphysema of lung with bronchitis.
Spermatorrhœa.
Pregnancy.
Diabetes mellitus.
Epilepsy.

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* See "Phil. Trans.," 1845, p. 365.

General Symptoms.—They are those of exhaustion with irritability. Depression of spirits, even to melancholy, with irritability of temper, often amounting to irascibility; great muscular debility, with a severe and constant pain or sense of weight across the loins; flatulent dyspepsia, well marked, and loss of flesh; all these symptoms corresponding very much to the phosphoric diathesis. But the deeper tinge, so to speak, of the symptoms referred to, and the peculiar olive-greenish colour of the skin, almost stamp with characteristic distinction the oxalic-acid diathesis. Certain additional symptoms will aid the diagnosis. Feverish excitement, with dryness of the palms of the hands and soles of the feet, especially towards evening, may be notable in severe cases; while the tendency to boils is of very frequent occurrence. Irritability of the bladder is, perhaps, equally frequent in either case, but the condition of the urine will at once determine the difference.

The symptoms of oxaluria must not alone be taken into consideration—apart from the state of the urine; for, as Dr. W. Roberts observes, these symptoms may be present in typical completeness without oxaluria; and conversely, oxaluria may exist in its highest intensity, and may even go on to the formation of a mulberry calculus, without evoking any of the symptoms—the patient, especially if a child, appearing to enjoy blooming health, until the supervention of vesical irritation from stone.

Physical Characters of Urine.—Clouded with much epithelium, and of a bright amber colour, somewhat resembling the bright golden-sherry colour of lithic-acid urine; but contrasting with the pale, whey-like urine of earthy phosphates, and the turbid orange-brown of ammoniacal urine, which, moreover, presents an iridescent pellicle on its surface, and is ropy and fetid. The specific gravity varies extremely, from 1·015, or less, to 1·025, or more. Quantity of urine not much increased. Reaction decidedly acid. No deposit of oxalate, unless present in some quantity, and after some hours or days; then appearing as minute, colourless, transparent, hemp-seed concretions, mingled with mucus as a cloudy deposit.

On being heated, the urine may become gelatinous, yet retain its transparency.

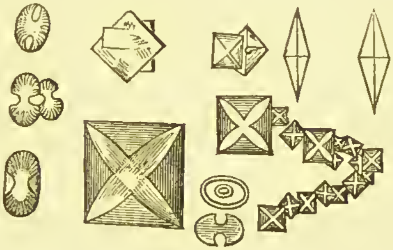

FIG. 77.

Microscopical Characters.—Crystals in three forms: octohedra, the most common, or as dumb-bell shaped crystals; occasionally in the shape of small, red blood-globules, probably the earliest stage of dumb-bell oxalate. All these are here represented (Fig. 77). It should, however, be noticed that the crystalline forms vary, as they turn over and assume different aspects under the microscope. The octohedra may thus appear as parallelograms, and the dumb-bell is seen as an ovoid.

Chemical Tests.—To determine the *whole* quantity of oxalic acid—free, or in combination with alkalies and soluble, or with lime, a portion of which oxalate may be precipitated—the urine of twenty-four hours must be collected. This should be evaporated to about one-fourth its bulk, neutralized with ammonia, be strongly acidulated with acetic acid to keep the phosphates dissolved, and then a solution of chloride of calcium added. The oxalate of lime thus formed is to be separated by filtration, dried, converted into either the carbonate or the sulphate in the usual manner, weighed, and the oxalic acid calculated from the resulting carbonate or sulphate. If there be any reason to suppose that the oxalate is mixed with uric acid, then dissolve in hydrochloric acid, filter, neutralize with ammonia, and again acidulate with acetic acid (Hassall).

Should any oxalate of lime have become deposited before examination, this may be either separated or redissolved.

To estimate the *diagnostic* importance of oxalate of lime in the urine, it should be remembered that this state is of very frequent occurrence, and its presence cannot be regarded as signifying a morbid blood-condition, excepting in respect of the *quantity* secreted. A few minute crystals are quite compatible with health; but large crystals in large quantity, and *persisting* for a considerable period, indicate such morbid condition.

The following observations by Golding Bird, respecting the composition of oxalic-acid urine, relate to the *circumstances* under which it occurs.

In rather more than one-third of the cases examined, uric acid or urates existed in large excess, forming the greater bulk of the existing deposit. In all there existed a greater proportion of urea than in healthy urine of the same density; and in nearly 30 per cent. of the cases, so large a quantity of urea was present, that the fluid crystallized into a solid mass by adding nitric acid. The urate of ammonia found in the deposits of oxalic-acid urine is occasionally tinted with a pink hue. An excess of phosphate frequently accompanies the oxalate. The presence of sugar in the specimens examined was exceptional.

Prout regarded the oxalic-acid diathesis as a substitute for that of lithic acid, the former being preceded and followed by the latter. Liebig demonstrated the intimate relation of lithic acid to urea and oxalic acid; the two latter having been formed artificially from the former; and this conversion of lithic acid was shown by Wöhler's experiments to take place in the bodies of animals. But " the most exact observations have failed to show that there is any inverse correspondence between the excretion of urea and lithic acid; both usually increase and diminish together " (W. Roberts).

Oxalic-acid urine—properly so called from the quantity of this acid excreted—is an expression of *many* morbid conditions. Taking patients indiscriminately in a hospital, Bence Jones concludes that oxalate of lime is notably present in the urine in nearly one out of three. Diseases of many kinds, and of opposite characters, are apparently conducive to this result: indigestion, especially if attended with flatulence, and in cases also where no indigestion was ever experienced; skin diseases, and in cases where the skin was never affected;

in acute rheumatism, acute gout, fever, and in diseases of women and children.

Beneke's observations have led him to the following definite conclusions:

1. Excess of oxalic acid has its proximate cause in an impeded metamorphosis—that is, in an insufficient activity of that stage of oxidation which changes oxalic acid into carbonic acid (the former differing from the latter only in containing half an atom less of oxygen).

2. Oxalic acid has, if not its sole, its chief source in the azotised constituents of the blood and food; everything, therefore, which retards the metamorphosis of these constituents occasions an excess of oxalic acid.

3. Such a retardation of the metamorphosis of the azotised constituents of the blood may be determined by the following causes:

a. Abuse of azotised articles of food (direct retardation).

b. Abuse of saccharine and starchy articles of food (indirect retardation).

c. Insufficiency of the red blood-corpuscles and (eventually) diminished oxidation.

d. Insufficient enjoyment of pure, fresh, ventilated air.

e. Organic lesions which in any way impede respiration and the circulation of the blood.

f. Conditions of the nervous system which bear a character of depression, whether these arise primarily from mental derangement, or from pathological states of the blood.

4. Excess of alkaline bases in the blood; and it is not

improbable that an increased production of lactic and butyric acids in the digestive canal, consequent thereon, impedes the development of the red blood-corpuscles, and thereby generates that chlorotic state which so often occasions and accompanies oxaluria.

5. Catarrhal conditions of the intestinal mucous membrane, in case they are accompanied by oxaluria, have at most only a common source. They may determine oxaluria by causing deranged digestion, but cannot be considered as its proximate cause.

The generally more healthy state of the urinary organs in connection with oxalic-acid urine, is an important consideration with reference to lithotomy or lithotrity.

Sulphuric Acid ($\mathrm{Ho,SO_3}$) *in Urine.*

Diseases associated:

Increased with	Diminished with
Fever, simple.	Bright's disease, acute.
Rheumatic fever.	„ „ chronic.
Acute pneumonia.	Chronic diseases generally.
Pyæmia after confluent smallpox.	Jaundice without fever.
	Cholera.
Delirium tremens.	Anæmia and chlorosis.
Acute capillary bronchitis.	
Acute phthisis.	
Typhoid fever.	
Smallpox.	
Milk fever.	
Acute pleurisy.	

Increased with

Chorea.
Diabetes mellitus.
Cholera.
Anæmia and chlorosis.

Physical Characters of Urine are not, apparently, peculiar, and therefore not distinctive. They would appear to resemble generally those of febrile urine. No deposit of sulphates ever occurs, they being soluble in urine—acid or alkaline—including ammoniacal urine.

Microscopical Characters.—Crystals of sulphates may be readily procured by evaporating a small quantity of urine on a slip of glass. The sulphate of *potash* then appears in the shape of short six-sided prisms, terminated by six-sided pyramids; but frequently the body of the crystal is wanting, thus presenting a triangular-faced dodecahedron. Also in the shape of rosettes and dumb-bells (Fig. 78). Sulphate of *soda* appears as decahedral crystals.

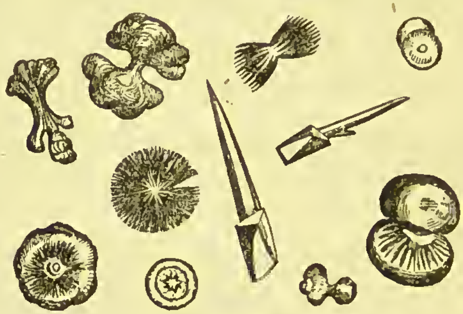

FIG. 78.

Chemical Tests.—By adding a soluble salt of baryta, *e.g.*, chloride of barium, the sulphate of baryta formed is insoluble and conspicuous, thus representing the sulphuric acid present; but not discovered by merely inspecting the urine, in which the sulphates of potash and soda are absolutely soluble, whether the urine be itself acid or alkaline. The readiness with which the insoluble baryta sulphate appears will show the excess of sulphuric acid.

The *whole* quantity of sulphuric acid present may be determined as proposed by Dr. Bence Jones :—about 500 grains of urine are weighed, and chloride of barium is then added in excess, a few drops of hydrochloric or nitric acid being used to ensure the solution of the phosphate of baryta. Heat is applied, and the liquid boiled for a few minutes briskly. The sulphate of baryta is filtered and washed until the clear liquid is perfectly free from chloride of barium. The filter is burnt, and the residue weighed. The amount of sulphate of baryta in a known quantity of urine is thus determined, and the whole amount in twenty-four hours can be calculated.

Diagnostic Value.—The interpretation of sulphuric acid in the urine is somewhat parallel to that of phosphoric acid. The quantity of either acid present absolutely and relatively to the other urinary constituents, is the question with reference to the blood-condition. Unlike phosphoric acid, *no part* of the sulphuric acid is ever deposited in combination, *i.e.*, as sulphates of potash and soda ; they being the only sulphates (excepting, perhaps, a little lime sulphate), and which are completely soluble in any urine, even alkaline urine. But the greater part—about three-fourths of the whole of the phosphoric acid—is in combination with these alkaline bases, and these phosphates are also completely soluble in any urine, and never deposited. While, therefore, mere inspection of the urine overlooks the greater portion of the phosphoric acid present, it discovers none of the sulphuric acid. On the other hand, the remaining small portion of phosphoric acid in combination with the earthy bases, lime and magnesia, being insoluble only in alkaline urine, their precipitation indicates and measures only the alkalescence of the urine,—by fixed alkali, potash or soda, or the volatile alkali, ammonia. Not even this chemical condition of the urine is discoverable through the sulphates, which never appear.

Chemical examination of the urine—as already described—by the formation of the sulphate of baryta, which is insoluble, and deposited accordingly, will discover the presence of sulphuric acid, and its whole amount.

Hippuric Acid ($HO,C_{18}HNO_5$) *in Urine.*

Diseases associated:

Increased with	Diminished with
Liver disease, *e.g.*, cirrhosis.	Jaundice, absent.
Dyspepsia, atonic.	Typhus fever.
Cholera.	Pneumonia ?
Chorea.	
Diabetes mellitus.	
„ insipidus.	

The General Symptoms are those of muscular weakness and nervous exhaustion, consequent, it would seem, on the deprivation of nitrogenous food and an excess of carbonaceous matter in the system. The accompanying condition of urine will, however, as usual, determine the diagnosis between this and other diseases, *e.g.*, excess of urea, phosphates, or oxalates, which present similar general symptoms.

Physical Characters of Urine.—The colour varies—pale, or, it may be, resembles that of febrile urine; the odour is generally like that of whey; specific gravity below rather than above the healthy average—1·020, and in one case (by Bouchardat) it varied from 1·006 to 1·008. Quantity copious. Reaction, generally, very faintly acid, neutral, or alkaline. A deposit of triple phosphate of magnesia not unfrequently occurs.

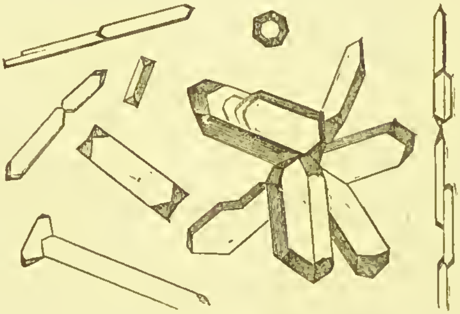

Fig. 79.

Microscopical Characters.—Crystals of the oblique rhomboidal prism, and its modifications, are obtained by evaporating two or three drops of fresh urine, to which a little hydrochloric acid has been added, on a slip of glass (Fig. 79). In stale urine, the hippuric will be found converted into benzoic acid; but its crystals, obtained in like manner, are characteristically different—thin glistening scales.

Chemical Tests.—Neutralize the acid with lime, concentrate by evaporation, add hydrochloric acid, in a flask, to decompose the hippurate of lime; introduce ether in large quantity, and cork the flask; agitate from time to time, pour off the ethereal solution which floats on the surface, wash it with water to remove traces of hydrochloric acid, and then evaporate to obtain the free hippuric acid.

If the ether should not separate readily from the mixture, add a very small quantity of alcohol; the water added removes the latter, and any urea in solution, as well as the hydrochloric acid.

Lactic Acid $(HO,C_6H_5O_5)$ *in Urine.*

Diseases associated:

Increased with

Febrile diseases.
Recurrent catarrh.
Oxalate of lime and uric acid.
Diabetes mellitus.
Rachitis.
Osteomalacia.
Pyæmia.
Leucæmia.
Puerperal fever.
Rheumatism?

Physical Characters of Urine.—Not distinctive.

Microscopical Characters.—Crystals of the lactates of zinc, lime, and copper may be obtained, which are characteristic; the former especially, being thick rhombic tablets in clusters, and those of lime having the appearance of double brushes.

Chemical Tests.—Evaporate fresh urine to the thickness of syrup, by means of a low temperature with the water-bath, treat the residue with alcohol holding oxalic acid in solution, treat the alcoholic extract with an excess of hydrated oxide of lead, filter the solution, remove the excess of lead by sulphuretted hydrogen, boil the filtrate with oxide of zinc, filter again and evaporate to concentration, and lactate of zinc will appear with its characteristic crystals.

Lactate of lime may be formed by first procuring a solution of lactate of baryta, and then decomposing with sulphate of lime.

Or, the lactate of copper, from that of lime, by adding sulphate of copper.

Chlorides in Urine.

Chloride of sodium ($NaCl$).
Chloride of potassium (KCl).
Chloride of ammonium (NH_4Cl).

Diseases associated:

Increased with	Diminished with
Diabetes mellitus.	Acute pneumonia.
Ague—cold and hot stages.	Acute pulmonary phthisis.
Chronic phthisis.	Acute capillary bronchitis.
Hot stage, and beginning of sweating.	Pleurisy.
	Acute rheumatism.
	Typhus fever.
	Typhoid fever.
	Scarlet fever.
	Erysipelas.
	Puerperal fever.
	Milk fever.
	Chronic febrile diseases.
	Chorea.
	Dropsy—cardiac, hepatic.
	Bright's disease—acute and chronic.

Physical Characters of Urine.—Not distinctive.

Microscopical Characters—The chlorine is, for the most part, in combination with sodium, and the chloride of sodium readily crystallizes. By evaporating a drop or two of urine on a slip of glass, crystals are obtained in the octohedral form, distinguished from those of oxalate of lime by their principal axis being longer, and by not polarizing light. Half-octohedra, which are occasionally striated, is another form. Dodecahedra, or twelve-sided crystals, are the rarest form. By evaporation also, or from a solution of the ash of urine, the salt often crystallizes in the form of crosslets and daggers (Fig. 80).

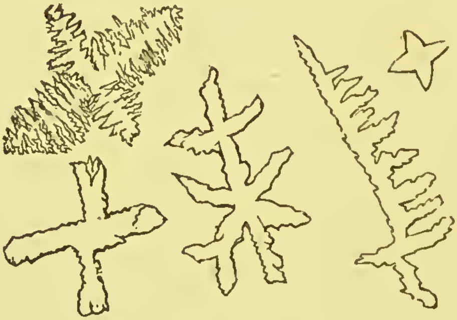

FIG. 80.

Chemical Tests.—Nitrate of silver, in solution, is a handy test for the presence, or qualitative determination, of chloride of sodium, in urine. One caution only is required: to strongly acidulate the urine with nitric acid, in order to prevent the precipitation of phosphate of silver; or the nitric acid may be added after the nitrate of silver, when any phosphate of silver will be immediately dissolved (Thudichum).

The quantity may be determined, either by weighing the white precipitate—chloride of silver; or volumetrically, by noting the quantity of a solution of nitrate of silver, of known and appropriate strength, required to separate the whole of the chlorine.

Sugar ($C_{12}H_{12}O_{12}$) *in Urine.*

Diseases associated:

Increased with	Diminished with
Diabetes mellitus.	Hysteria?
Dyspepsia.	Epilepsy?
Gout.	Asthma?
Injuries of head.	Emphysema, pulmonary?
Cholera.	Phthisis?
Hypochondriasis.	Acute pneumonia—sputa?
Urine of old persons.	Hooping-cough—after?
After chloroform of 24 hours' administration.	
Pregnancy and lactation.	
Lactation with suppression.	

General Symptoms of Diabetes Mellitus—Mellituria—Glucosuria.—Approaching assiduously, the quantity of urine becomes notably increased, owing to the diuretic action of sugar: micturition, also, is more frequent and urgent, from the presence of sugar in the urine secreted, and thus irritability of the bladder is established. This constant drain of water through the kidneys is necessarily attended with a diminished discharge through the other channels; hence dryness and roughness of the skin, the cuticle powdering off, constipation, a pasty tongue, not unfrequently red and cracked, unquenchable thirst, craving hunger, with progressive emaciation, partly due to actual wasting, partly to the drying up of the body consequent on the incessant renal discharge of water from the system. The quantity of fluid drunk daily averages from 8 to 12 pints; but it may amount to double the latter quantity, or more; although without assuaging the insatiable thirst, or relieving the clamminess or parched dryness of the mouth. The haggard expression of the face expresses the patient's torment. Pulmonary symptoms of phthisis, with hectic fever, sometimes supervene. Debility progressively accompanies the wasting and mummification of the body—some œdema, perhaps, of the legs contrasting with the otherwise collapsed appearance of the sufferer; yet the mind remains unclouded to the last.

Diabetes *mellitus* is the expression sometimes used for that disease whereof sugar in the urine is the sign; and this attributive title seems necessary to distinguish ordinary diabetes from a variety contra-designated Diabetes *insipidus*. In the former, farinaceous matters are probably converted into dextrin, and thence at once into grape-sugar; but there is some reason to believe that this succession of metamorphoses may be interrupted, and that an *insipid* sugar is then formed intermediately between dextrin and sugar of milk (Bence Jones). This tasteless sugar resembles sugar of milk, differing from it in not giving rise to mucic acid and in undergoing fermentation. It can be converted into grape-sugar by the action of acids.

Diabetes insipidus has received other names—Polydipsia (Becquerel), Diuresis and Hydruria (Willis). The secretion thus signified, of a large quantity of *watery* urine, is probably a distinct disease. Aqueous diabetes commonly occurs in connection with hysteria; and the term *hydruria* distinguishes it from *azoturia,* of which disease an excessive excretion of *urea* is the prevailing characteristic. The absolute amount of urea excreted in the twenty-four hours may be increased in hydruria; no sample, however, of such urine contains its normal proportion to the water secreted.

Physical Characters of Urine.—Clear, pale-straw, or greenish tint, sweet smell and taste; specific gravity high, averaging 1·040, and the quantity much increased, to 100 ounces, or even 400 ounces, in twenty-four hours. A crystalline deposit of sugar readily forms as an efflorescence on any clothing or other surface where the urine may happen to dry. The reaction is acid, but neutral or slightly alkaline if the quantity of sugar be small and the urine fresh. Ultimately, the sugar may disappear, and the urine become albuminous and scanty.

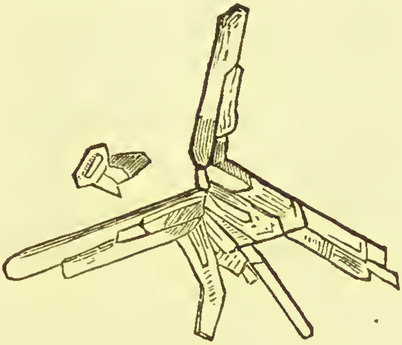

FIG. 81.

Microscopical Characters.—Crystals in the shape of rhombic plates, six-sided, aggregated into roundish granules, or as single plates (Fig. 81).

Chemical Tests.—The composition of diabetic urine is peculiar in containing a *foreign* ingredient—glucose, or sugar of the grape, and which is excreted, possibly, in quantity varying from 1 lb. to 2 lbs. or more, in twenty-four hours; whereby a patient may pass more than his own weight of sugar in the course of a few months. The urine contains, also, usually rather more than less of its ordinary constituents.

Diagnostic Value.—Saccharine matter is occasionally present, and as a mere trace, in healthy urine; but any more obvious quantity, and *persistent,* is abnormal.

To estimate the pathological significance of diabetic urine, therefore, the constant presence of sugar in any notable quantity, rather than its absolute amount, is the diagnostic sign of consequence.

To detect this morbid condition in its infancy—indicating a corresponding blood-condition—certain tests, more delicate even than the production of the rhombic crystals, can be applied with signal success.

Yeast, or Fermentation Test.—This is easily applied. Add a small quantity of yeast to some of the suspected urine in a saucer; invert a test-tube filled with this mixture, and stand it in the saucer; then place the whole in a warm room. If sugar be present, fermentation soon begins, and bubbles of carbonic acid rising in the tube accumulate and depress the fluid. Minute fungoid growths also are developed, which can be seen with the aid of the microscope. Another fungus—*peni-*

cilium glaucum (Fig. 82, to left)—the mildew that overspreads decaying vegetable or animal matter, and which may appear in *non*-saccharine urine, is apt to be mistaken for this "yeast-plant"—*torula cerevisiæ* (Fig. 82, to right). Their distinctive microscopic characters were pointed out by Dr. Hassall.*

Certain *chemical* tests are more conclusive. They all depend on the facility with which the composition of diabetic sugar is changed; and this can be readily effected by salts of copper, and by alkalies.† Full directions for the successful application of these tests are given in Golding Bird's work;‡ the following particulars, however, are essential to our purpose—the early and exact detection and discrimination of diabetic urine:

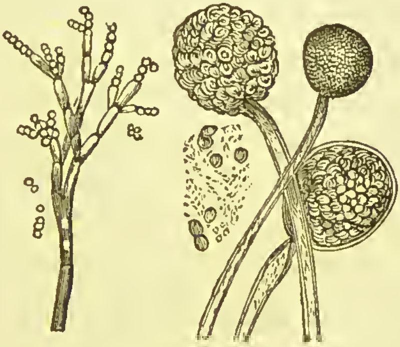

Fig. 82.

Copper, or *Trommer's Test.*—Add to the suspected urine in a large test-tube just enough of a solution of sulphate of copper to communicate a faint blue tint. A slight deposit of phosphate of copper generally falls. Liquor potassæ must then be added in great excess; a precipitate of hydrated oxide of copper first falls, which redissolves in the excess of alkali if sugar be present, forming a blue solution like ammoniuret of copper. On gently heating the mixture to ebullition, a deposit of red suboxide of copper falls, if sugar be present.

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* "The Urine in Health and Disease," pp. 149-151.

† See "Med. Chir. Review," January, 1853. Lionel Beale.

‡ "Urinary Deposits." Edit. by Dr. Birkett.

Fehling's Test Solution may be used as in Trommer's test. This solution consists of 69 grs. of sulphate of copper, dissolved in 5 times its weight of distilled water; to which is added a concentrated solution of 268 grs. of tartrate of potash, and then a solution of 80 grs. of caustic soda in one ounce of distilled water.

Cappezzuoli's Test.—Add a few grains of blue hydrated oxide of copper to urine in a conical glass vessel, and render the whole alkaline by adding liquor potassæ. If sugar be present, the fluid assumes a reddish colour, and in a few hours the edge of the oxide deposit acquires a yellow colour, which gradually extends through the mass, owing to the reduction of the oxide to a metallic state (suboxide ?).

Potash, or *Moore's Test.*—Place in a test-tube about 2 drachms of the suspected urine, and add nearly half its bulk of liquor potassæ. Heat the whole over a spirit-lamp, and allow active ebullition to continue for a minute or two; the previously pale urine will become of an orange-brown or even a bistre tint, according to the proportion of sugar present. The subsequent addition of an acid generally causes the evolution of an odour of boiling molasses. Should the liquor potassæ contain lead, a dark colour is produced by the sulphur in the urinary excretion acting on it, which might lead one to suspect the presence of sugar when none exists—a source of error first pointed out by Dr. Owen Rees. Hence it is important to preserve the test-solution in bottles of green glass free from lead.

For Traces only of Sugar.—Certain tests are appropriate for the detection of sugar, when present in otherwise unappreciable small quantity—as a mere trace. The application of such tests implies the previous separation of some of the other constituents, which would interfere with their action.

(*a*) *Brücke's Test.*—Add to the suspected urine, neutral acetate of lead, and afterwards basic acetate of lead. Separate the precipitate by filtration, and add ammonia to the solution. The precipitate, by ammonia, is decomposed by oxalic acid, or suspended in water, and sulphuretted hydrogen passed through it. The filtered solution contains the sugar, which can then be detected by any of the tests already described.

This process will detect the seventh of a grain of sugar, diluted with more than six ounces of water; and two-thirds of the whole quantity of sugar present in a solution can be separated.

(*b*) *Maumene's Test.*—Soak strips of woollen rag in a solution of perchloride of tin—one part of perchloride to two parts of water—for four or five minutes. Dry the slips over a water-bath. Let fall a drop of the suspected urine on one of these prepared strips, dry it, and expose to the dull red heat of a spirit-lamp. If only a trace of sugar be present, a black spot appears.

(*c*) *Chromate of Potash Test.*—Mix equal parts of neutral chromate of potash and solution of potash with the suspected urine, and boil; if sugar be present, a green colour, by the formation of oxide of chromium, is produced (Horsley). A modification of this test may be made: a solution of bichromate of potash is decomposed by excess of sulphuric acid; mix this with the urine, and boil; a beautiful green colour appears. This reaction is not affected by urea, the urates, or albumen (Luton).

(*d*) *Picric Acid Test* (*Dr. George Johnson*).—Picric acid boiled with a solution of potash is a most delicate test for glucose. The reduction of yellow picric to the deep-red picranic acid by glucose when boiled with potash, although noticed by Braun nearly twenty years ago, appears not to have been utilized as a practical test. ʒj of a solution of grape-sugar, gr. j to ℥j, is mixed with ʒ½ of liquor potassæ (B.P.), ♏10 of a saturated solution of picric acid, and made up to ʒiij with distilled water. The mixture is placed in a boiling-tube ten inches long and three-quarters of an inch wide, having a mark made at the height of ʒiij. It is then heated to the boiling-point, and kept boiling for sixty seconds. The resulting colour indicates gr. ¼ sugar to ℥j. This colour may be exactly imitated by a solution of acetate of iron, with excess of acetic acid, which is used as a standard in making a quantitative analysis. The depth of colour is directly proportioned to the amount of sugar present to decompose the picric acid. When the colour is deeper than the standard, the dark liquid is diluted until it and the standard have the same tint. The dilution is effected in a tube twelve inches long, divided into equal 1-10th inch and 1-100th parts. By the side is a tube of equal size, containing the standard colour. A more exact comparison of the colours is made by looking through equal columns of the saccharine liquid, and the standard in flat-bottomed tubes held over white paper or porcelain. Ten minims of solution of picric acid are rather more than equivalent to the sugar (1-8 grs.) in ʒj of a solution containing gr. j to ℥j. In making an analysis the picric acid must be in proportion to the amount of sugar. If the proportion of sugar be as high as six grains to the ounce, about a drachm of solution of picric acid will be required for a drachm of the sugar solution. When the amount of sugar is more than six grains to the ounce, the liquid should be diluted in a definite proportion before it is analyzed. Distilled or pure rain water is used for dilution. Hard water becomes turbid when mixed with caustic potash. If undiluted urine is rendered turbid by phosphates in process of testing, it should be cleared by filtration. The measurements and dilutions must all be accurate. The presence of albumen even in large amount does not interfere practically with the picric-acid test. The accuracy of the test is proved by practically identical results from analyzing the same specimens by Dr. Davy's ammonious cupric solution, and by the picric acid and potash. An analysis of about 300 specimens of normal urine by the picric-acid process indicates the constant presence of a substance capable of reducing picric acid and cupric oxide in proportions equivalent to from 0·5 to 0·7 grains of glucose per ounce, but apparently differing from glucose in the fact that it cannot be made to undergo the vinous fermentation under the influence of heat, etc.*

To Estimate the Quantity of Sugar.—By the *Fermentation Test*, the quantity of sugar present in diabetic urine may be estimated according to either of two of the results of this process:

(*a*) *By measuring the volume of Carbonic Acid produced.*—The mixture of yeast and urine is placed in a graduated tube, inverted over mercury. When the fermentation is finished, in from six to twelve hours, at a temperature of 100° Fahr., the volume of gas formed is thus indicated, and subject to correction for temperature and pressure, the amount of sugar can be calculated. One cubic inch of carbonic acid represents nearly one grain of sugar.

(*b*) *By the diminution in specific gravity or weight of the Urine, after destruction of the Sugar by complete fermentation; as compared with the weight before this process*—Dr. W. Roberts's method. The difference of specific gravity here indicates the quantity of sugar. Two portions of urine, of four ounces each, are placed in separate bottles of about twelve ounces capacity. In one is placed a piece of German yeast, the other is tightly corked. Both are placed in a warm place for twenty-two hours, until fermentation is complete. The bottles are removed to a cooler locality, and after two hours the density of the fluid in each bottle is tested by the urinometer. Every degree of density lost, by the fermented sample, indicates one grain of sugar in each fluid ounce of urine.

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* Clin. Soc. Lond., 1883, March 9th.

Albumen in Urine—Albuminuria.

Diseases associated:

Bright's disease, acute and chronic.
Scarlatina.
Disease of heart.
Cholera.
Diarrhœa.
Puerperal convulsions.
„ fever.
Typhoid fever.
Typhus fever.
Pneumonia.
Bronchitis.
Phthisis.
Rheumatism, acute.
„ subacute.
Pregnancy.
Intermittent fever.
Measles.
Smallpox.
Peritonitis.
Pleurisy.
Erysipelas.
Paralysis.
Purpura.
Diseases with blood in urine.

Dr. W. Roberts thus arranges the diseases in which albumen appears more or less constantly in the urine:

(1) Acute and chronic Bright's disease of the kidneys.

(2) Pregnancy and the puerperal state.

(3) Febrile and inflammatory diseases; zymotic diseases; such as scarlet fever, measles, small-pox, typhoid, cholera, yellow fever, ague, diphtheria, etc.; inflammatory diseases, such as pneumonia, peritonitis, traumatic fever, acute articular rheumatism, etc.

(4) Impediments to the circulation of the blood—emphysema, heart-diseases, abdominal tumours, cirrhosis, etc.

(5) A hydræmic and dissolved state of the blood and

atony of the tissues, such as purpura, scurvy, pyæmia, hospital gangrene; also hæmatinuria.

(6) Lead-poisoning.

(7) Nervous disturbance—neurotic albuminuria.

General Symptoms of Bright's disease of the kidneys. —Certain structural changes in the kidney are the immediate causes of the symptoms. These changes are: congestion,—the kidneys being enlarged by engorgement of blood, and having a deep purple colour; followed by interstitial effusion, affecting chiefly the cortical or secreting portion of the gland, with enlargement, pale colour, and moderately firm consistence; degeneration,—fatty or waxy (amyloid) degeneration of the effused matter, with some physical alterations of colour and consistence; or, lastly, partial absorption and contraction,—producing a small, firm, remnant kidney, having an irregular puckered surface, and granular aspect when the adherent capsule is withdrawn,—granular degeneration.

The first of these conditions has been named by Dr. G. Johnson acute desquamative nephritis,—fibrinous casts of the uriniferous tubules, with epithelial cells, coming away in the urine; the second, chronic non-desquamative nephritis; while the third condition might be termed the atrophied or remnant kidney.

Whether we regard these structural changes as a consequential series, or as so many independent forms of renal disease, they are one and all included under the title—Bright's disease,—for with each, albuminous urine is invariably connected.

The symptoms incident to each of these alterations of structure necessarily vary, yet they are substantially the same.

Congestion of the kidneys, beginning with pain or weight in the loins, sickness, and general febrile disturbance, is accompanied with albuminous urine, and the retention of urea and water in the blood, with its effusion into the cellular texture generally: the face assuming a pale, puffed, and heavy appearance, while the lower limbs especially become œdematous, from below upwards, but the swelling pits little on pressure with the finger. This state constitutes "febrile dropsy," as from *acute* Bright's disease, in its earliest stage. The blood and urine have, in respect to each of their prominent constituents, albumen and urea, changed places. While, therefore, the nutrition of the body is undermined by the constant abstraction of the one, the system, through the blood, is poisoned by the retention of the other. Hence the symptoms of uræmia, which are of a typhoid character, and prominently those of "febrile oppression;" the functions of the nervous system being overwhelmed, as by intoxication, and stupor or coma induced. Urea in the circulation may affect various organs, giving rise to particular symptoms. Meningitis with its symptoms, or those of cerebral irritation only, as headache, convulsions; pleurisy, pericarditis, or peritonitis; irritation of the bronchial, or of the gastro-intestinal mucous membranes. Add to which, degeneration of other organs, especially the heart, liver, and vessels of the brain, is not unfrequently a coexisting or consequential condition, thus giving rise to *their* additional symptoms. Dropsy, owing to the concomitant retention of water in the blood, may be called an accidental symptom.

The same essential symptoms of Bright's disease of the kidneys, are connected also with the alterations of *structure* which—as *chronic* forms of disease—occur in consequence, or perhaps independently, of congestion; but little, or perhaps no albumen is passed, although water escapes freely in the urine, while the urea and other solid urinary constituents are still retained in a progressively greater proportion in the blood; thus reducing the urine to almost a mere discharge of water, and often in great quantity. The scanty secretion of urine during congestion, contrasts with this diuresis-anazoturia. Micturition is more frequent, and perhaps urgent, in the one case, and more abundant in the other. In both, irritability of the bladder is excited by the unaccustomed urine.

Physical Characters of Urine, in Bright's disease—*Acute.*—Colour, smoky brown, or dark, like porter; easily froths, owing to the presence of albumen; specific gravity low, averaging 1·014, by abstraction of the urea; quantity of urine much diminished, owing to the reduced proportion of water. On standing, there is an abundant deposit of a brownish or chocolate-coloured, flocculent matter, resembling the sediment from beaf-tea. This sediment, as well as the smoky tint of the urine, are alike due to the presence of altered blood; and corresponds to the condition of febrile dropsy. In *chronic* conditions, the urine becomes pale and opalescent, and is less apt to froth, there being much less albumen: the specific gravity declines yet lower, down perhaps to

1·004, while the quantity of urine is increased, approaching even to diuresis. The reaction is, generally, much less acid than in health.

To determine the average specific gravity of the urine, a mixed sample should be taken from the secretion in twenty-four hours; or the examination should be made at least twice—morning and evening. When the urine is most concentrated—in the morning, before breakfast—a constant specific gravity, below the healthy average minimum of 1·015, would almost surely indicate the presence of albumen.

The specific gravity of the serum of the blood is reduced to 1·018 or even to 1·015, as compared with that in health, which ranges between 1·029 and 1·031.

Microscopical Characters.—Casts of the uriniferous tubules, blood, and perhaps pus, may pass in the urine, which presents accordingly characteristic appearances under the microscope; but their description scarcely relates to the composition of the urine secreted, nor are these organic deposits essential to albuminuria. For an accurate description of the various kinds of uriniferous tube-casts, the reader may consult Dr. W. Roberts's valuable treatise.*

Chemical Tests.—The solid constituents of the urine, amounting in health to about 68 in 1000 of urine, in Bright's disease declines to 14, 12, or even 6 parts only in 1000. This is chiefly due to the abstraction of urea, alluded to in connection with the altered physical characters of the urine. The quantity of albumen contained in the urine varies exceedingly; from a mere trace, to possibly 545 grs. in the twenty-four hours. (Parkes.)

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* "Urinary and Renal Diseases," 3rd. edit., p. 117.

The presence, or, as in the early stage it might be termed, the substitution of albumen for urea, is easily discovered and readily distinguished, provided only certain precautions be observed in making the examination.

They relate either to the chemical composition of the urine submitted to examination, or to the tests employed; chiefly, these precautions have reference to the urine itself.

Albuminous urine is not merely a solution of albumen. So far as it *alone* is concerned, by applying heat to such urine, the albuminous portion—white of egg—begins to coagulate at 160° Fahr., and gradually solidifies as the temperature rises to 212°. But this urine contains other ingredients, and their variations in quantity interfere with the coagulation of the albumen.

Thus, if the urine be alkaline, or even neutral, whether from the presence of volatile alkali,—carbonate of ammonia, or from fixed alkali, as soda, either alkali will combine with albumen, and neither of the resulting compounds being coagulable by heat, the urine remains clear when heat is applied. The albumen is not discovered, although perhaps abundant. Or again, if an opposite condition exists,—should the urine be over-acid, from the presence of a free acid, as the acetic or hydrochloric, the acid will combine with albumen, and the acetate and hydrochlorate of albumen being uncoagulable by heat, the urine remains clear when heated. The albumen is concealed.

Supposing, however, that, on the application of heat, a white flaky precipitate does fall, resembling albumen, it may not be albumen. Earthy phosphates are likewise precipitated by heat. To distinguish between these two deposits—phosphates and coagulated albumen, as well as to evolve albumen concealed by an alkaline or over-acid state of the urine—heat having been applied, nitric acid (strong) should then be dropped into the test-tube, containing supposed albuminous urine. If the deposit be phosphates, they are re-dissolved; if albumen, it is more firmly coagulated.

Nitric acid *unaided* will precipitate albumen, but it also liberates lithic acid from the lithates, and combines with urea; when, therefore, either of these constituents is present in excess, a brown deposit of lithic acid or nitrate of urea forms and disguises the albumen. Both precipitates, however, together with the lithates, are re-dissolved by heat, which, on the contrary, discloses albumen.

In short, *heat* clears off any difficulty arising from lithic acid, the lithates, and urea; *nitric acid* clears off any difficulty arising from the (earthy) phosphates, at the same time liberating and evolving albumen from any prevailing alkaline or mineral acid condition.

Nitric acid, in respect of its behaviour to albumen, disputes with heat the privilege of disclosing the presence of this abnormal constituent of urine. Nitric acid unites with albumen, forming what may be called nitrate of albumen, which is not coagulable by heat. Consequently, if only just so much acid be added to albuminous urine as shall combine with all the albumen present, and form this nitrate, none of the albumen will appear when heated. Nitrate of albumen being *insoluble* in nitric acid, appears when *more* acid is added; but is again redissolved on the addition of an *excess* of acid. The happy *medium* quantity of acid is necessary to exhibit albumen—not just an equivalent, which combining with the whole amount present, renders it insoluble, although heated; this would be too small a proportion of acid; while an excess—above that proportion in which the nitrate of albumen is insoluble—redissolves it.

To strike the balance, and moreover obviate all other possible difficulties to which I have referred, the right method of examining supposed albuminous urine is simply this: Pour a *small* quantity—say a fluid drachm—of the urine into a test-tube; heat it to the boiling-point, and then drop in *two* or *three* drops only of strong nitric acid. If phosphates have been precipitated by the heat applied, they will be redissolved, and the white flakes of coagulated albumen appear more clearly. On being allowed to stand, it will subside in the tube, leaving the urine above clear; thus defining the quantity of albumen present in any given quantity of urine examined. This will be found, as already said, to vary between two extremes; a slight white cloudiness subsiding as a little flaky deposit, or part or the whole sample becoming solid and white, like coagulated albumen of an egg, in the tube.

For Traces only of Albumen—Picric Acid Test (M. Galippe, Dr. George Johnson).—Although picric acid was originally recommended by Dr. Galippe, in

1874,* as a delicate test for the presence of a very minute quantity of albumen in urine, the full appreciation of this test is due to Dr. George Johnson, by the suggestion of his son, Mr. G. S. Johnson; the former of whom gives the following precise directions for its application.†

The test may be used in the form of a saturated aqueous solution, or in the form of powder or crystals. To make a saturated solution, add to the powder or crystals fifty times their bulk of boiling distilled water; a portion of the acid will crystallize out on cooling, leaving a transparent yellow supernatant liquid. This solution being added to an equal volume of urine in a test-tube, immediately coagulates albumen. The coagulated picrate of albumen is soluble in alkalies. If, therefore, the urine be alkaline, it must be acidulated before adding the picric-acid solution. To detect a very minute quantity of albumen, the following method is the best: Take a test-tube about six inches long, and pour into it urine to within two inches of the top; slope the tube, and pour in slowly about an inch of the solution of picric acid, which will mix with the upper layer of urine, and the yellow mixture will become turbid with coagulated albumen, thus contrasting with the pellucid unstained urine below. Place the tube in a stand, and after two or three hours the coagulated albumen will have subsided and formed a delicate horizontal film at the junction of the coloured with the unstained stratum of urine, the yellow liquid and unstained urine below being quite free from turbidity. In testing with the powder or crystals, put as much as is equal in bulk to a small peppercorn into the bottom of a test-tube, and pour in a column of urine about one inch in height. Shake the mixture briskly, and as the powder dissolves the urine becomes turbid with coagulated albumen. The object is to add as much of the test as the urine will quickly dissolve, and no more. As the powder dissolves more rapidly than the crystals, it is better adapted for testing with the dry acid. The application of heat quickens the solution of the powder, and so hastens the coagulation of the albumen.

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* *Med. Times and Gaz.*, vol. ii. p. 366.

† Clin. Soc. Lond., 1883, March 9th.

To exactly estimate the quantity of Albumen.—Either of the two following processes may be resorted to:—

Take 500 grs. of the urine of twenty-four hours, and boil it in a flask, nitric acid being added subsequently, to secure coagulation of the albumen, and to dissolve any of the phosphates deposited by boiling. Then let the coagulated albumen subside by standing the flask, decant off the clear fluid, and throw the residue upon a weighed filter. Wash the collected albumen on the filter, with hot distilled water, to bring away saline matter; dry on the water-bath, and weigh.

Or, acetic acid may be added, in just sufficient quantity, and the urine boiled, thus to effect coagulation. The process is then concluded in like manner.

Diagnostic Value.—The significance of albuminous urine is its *persistence*, which is pathognomonic of Bright's disease of the kidney. With rare exceptions, this disease is invariably accompanied with albuminous urine, and this condition of urine persisting is a sure sign of that disease, and of no other.

Temporarily, albuminous urine is associated with many other diseases, most of which are specified in the table.

Bile in Urine.

Diseases associated:

Jaundice from obstruction.
Acute Hepatitis.
Cirrhosis of liver.
Acute yellow Atrophy.
Pneumonia.
Smallpox.
Scarlet fever.
Puerperal fever.
Pyæmia.
Urine in hot weather.
Urine of Pregnancy.

General Symptoms of Jaundice.—Certain structural changes in the liver are the immediate causes of the symptoms. These changes are: some *mechanical* impediment, which, precluding a free flow of bile into the duodenum, permits absorption of the bile imprisoned. The obstacle in question may be constriction, or closure of—as by a gall-stone impacted in—the common bile-duct, the hepatic duct, the cystic duct, or of the bile-ducts within the liver;* or the impediment may be due to some external cause of pressure on either of the ducts, as by thickening of the pylorus, duodenum, or head of the pancreas; or a tumour within the liver itself, overlaying the ducts. Without any obvious mechanical impediment to the free escape of bile, *suppression of its secretion* is more frequently the occasion of deficient elimination of bile. Structural disease of the liver, *e.g.* inflammation, acute and chronic, cirrhosis, fatty degeneration, operates in this way. So, also, various blood-poisons, *e.g.* through snake-bites, pyæmic infection of the blood, typhus, and malaria, intermittent, remittent, and yellow fever, severally give rise to jaundice. Ether and chloroform, likewise, are said to occasionally have this effect. In all these cases the liver itself may be structurally healthy; the blood-poison alone is the cause of a suppressed secretion of bile, which, in turn, reacting upon the blood, induces jaundice. Similarly, through the nervous system, mental emotions have, in some cases, paralyzed the liver, and produced this disease.

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* "Diseases of the Liver," Frerichs. Translated by C. Murchison, M.D., vol. i.

The symptoms of each of these causative conditions are those of jaundice—a yellow or yellowish-green discolouration of the skin and conjunctivæ, and of the urine, with light drab-coloured fæces. These appearances are due to the presence or absence of biliary colouring-matters. The retention of bile in the blood circulating is, like urea, sedative to the vital powers of the nervous and muscular systems, irritative in its operation on certain parts, locally. Hypochondriacal depression, weariness, and great weakness, are not unfrequently accompanied with an intolerable itching of the skin, and irritability of the urinary bladder, as biliary colouring-matter escapes by the urine. The want of bile in the small intestine renders the process of digestion incomplete; and the inappetency or even loathing of food occasioned by the bile retained in the system, is accompanied with imperfect chylification of the scanty ingesta, and the separation of pale yellow fæcal matter; while habitual constipation is relieved by occasional colicky diarrhœa. Progressive emaciation necessarily follows this constant starvation; and the withered, discoloured appearance of the individual, melancholy, exhausted, and dyspeptic, cannot fail to convey the impression of jaundice. Examination of the urine will at once settle the question.

The passage of a gall-stone is attended with paroxysmal pain in the epigastrium—always severe, sometimes excruciating, according to the size of the stone *in transitu*—hiccup, vomiting, and constitutional disturbance; but, in general, inflammation and its symptomatic fever do not supervene.

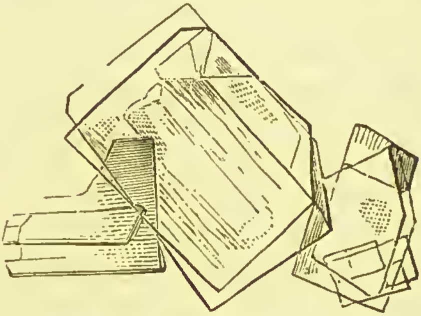

FIG. 83.

Physical Characters of Urine.—Colour, dark saffron, green or black; leaving a bright yellow, or other stain, on white linen. Other characters are not peculiar.

Microscopical Characters.—Certain constituents of the bile, when present in urine, may be obtained in crystalline forms. Taurine, as regular hexagonal prisms, with four or six-sided sharp extremities, the elementary form being a right rhombic prism. Crystals of cholesterine may also be found. (Fig. 83.)

Chemical Tests—are the most delicate means of detecting the presence of biliary *colouring-matters*, when escaping by the urine in quantity too minute to be visible, or made visible by staining linen.

Nitric Acid.—Pour on a white plate, or sheet of writing-paper, a small quantity of the suspected urine, so as to form an exceedingly thin layer, and carefully allow a drop or two of nitric acid to fall upon it. An immediate play of colours, green and pink predominating, will, if the colouring-matter of bile be present, appear around the spot where the acid falls.

Heller's Test.—Add to the urine any albuminous fluid —serum of blood or white of egg; then pour in sufficient nitric acid to produce a considerable albuminous coagulum. Examined after a short repose, it will present a bluish or green colour if bile pigment existed in the urine; whilst, if none were present, the deposited mass will be white or merely slightly yellow.

But albumen precipitated by nitric acid in urine, destitute of bile, is more or less coloured, bluish or reddish; this appearance arising from the action of nitric acid on the colouring-matter of the urine—uroxanthine. Dr. Basham has observed this urinary coloured albumen most frequently in acute renal dropsy, and it is a very unfavourable sign.

Acetate of lead precipitates albumen, if present, in bilious urine, of a yellowish colour.

Colour of Phosphates.—After exposure of urine for a day or two, crystals of triple phosphates are deposited, having a yellow tinge. A very delicate and pretty test of bile colouring-matter. (Hassall.)

For Bile Acids.—(*a*) *Pettenkofer's Test:* To a small quantity of the suspected urine in a test-tube, two-thirds of its volume of sulphuric acid are to be carefully added, taking care that the mixture, which soon becomes hot, never exceeds a temperature of 144°. Three or four drops of a solution of one part of sugar to four of water are then added, and the mixture shaken. A violet-red colour is developed if bile be present. This familiar test was not much credited by Golding Bird. His experience led him to doubt its accuracy, and in applying it there are numerous sources of fallacy to be guarded against; chiefly, that the action of sulphuric acid on sugar develops a red colour in the absence of bile. A mixture of albumen or oil with sugar will, even in very minute quantities, under the action of sulphuric acid, produce a purple or scarlet colour, as Raspail long ago observed.

(*b*) *Hoppe's Test*—for a *trace* of bile acid. Treat the suspected urine with excess of milk of lime, and boil for half an hour. Filter, and evaporate the clear fluid nearly to dryness, and then decompose with excess of strong hydrochloric acid. Boil the mixture for half an hour, renewing the acid from time to time, so as to prevent the spurting which would occur from over-concentration. Let the mixture completely cool, and then dilute with from six to eight times its volume of water. Filter the turbid solution, and wash the resinous mass, until the water runs through quite colourless. Dissolve the residue in spirit, containing 90 per cent. of real alcohol, decolorize with animal charcoal, again filter, and evaporate to dryness over a water-bath. The yellowish resinous residue is pure *choloidic* acid. On warming it, a peculiar musk-like odour is emitted. Dissolve this resinous matter in a little caustic soda and warm water, add a little sugar, and let fall, slowly, three drops of concentrated sulphuric acid into the mixture. The resinous acid is at first precipitated ; but afterwards, the flakes adhering to the glass are slowly dissolved by adding more sulphuric acid, and there appears an entirely clear fluid, of a beautiful *dark violet* colour ("Virchow's Archiv," vol. xiii.; "Archives of Med.," vol. i.). This test results from an elaborate process, but it is a very delicate and infallible one.

The following useful tables are from Dr. Golding Bird's work ;* they contain reference to some deposits not hitherto described in this work, but which are here incidentally introduced :

(1) *Table for the Microscopical Examination of Urinary Deposits.*

Deposit amorphous, and disappears on the addition of liquor potassæ . . . . Urates.
" " and permanent on the addition of liquor potassæ . Phosphate of lime.
" visibly crystalline, and the crystals octohedral† Oxalate of lime.
" " and the crystals hexagonal tables; soluble in ammonia . . Cystine.

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[*] "Urinary Deposits," etc. Edited by Dr. Birkett.

[†] Arsenious acid, chloride of sodium, and the protoxide of antimony, assume the octohedral form, but are rarely present.

Deposit visibly crystalline, and the crystals prismatic, or penniform; not soluble in ammonia, but in acetic acid . . . Neutral triple phosphate.

„ „ and the crystals radiated or foliaceous; not soluble in ammonia, but in acetic acid, with effervescence . . Carbonate of lime.

„ „ and the crystals radiated or foliaceous; not soluble in ammonia, but in acetic acid, without effervescence . . . . . Bibasic triple phosphate.*

„ „ and the crystals dumb-bells; not soluble in ammonia, but in acetic acid, with effervescence . . Carbonate of lime.

„ „ and the crystals dumb-bells; soluble by heat, but not in ammonia, nor acetic acid. . . Lithate of soda.

„ „ and the crystals dumb-bells; insoluble by heat, ammonia, and acetic acid . . Oxalurate of lime.†

„ „ and the crystals dumb-bells, with fringed edges; insoluble in alcohol and acetic acid, but soluble in liquor potassæ . . Lithic acid.

„ „ and the crystals lozenge-shaped or compound; insoluble in acetic acid and ammonia . . Lithic acid.

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* Is not yet proved to exist in urine (Thudichum).

† Ibid.

Deposit visibly crystalline, and the crystals spherical, with or without spicules; soluble by heat . . . . Lithate of soda.

(2) *Table for Discovering the Nature of Urinary Deposits by Chemial Reagents.*

Deposit white, and soluble by heat . . . . Lithates.
„ „ and insoluble by heat, but soluble in ammonia . . . . Cystine.
„ „ and insoluble by heat and ammonia, but soluble in acetic acid . . Earthy phosphates.
„ „ and insoluble by heat, ammonia, and acetic acid .. . Oxalate or oxalurate of lime.
„ coloured, and visibly crystalline . . Lithic acid.
„ „ and amorphous, but pale, and readily soluble by heat . . . Lithates.
„ „ deeply, amorphous, and slowly soluble by heat . . Lithates stained by purpurine.

Various *Organic* deposits are met with in the urine.* Some such deposits as pus, mucus, blood, and morbid growths, have been noticed in connection with cystitis, hæmaturia, and cancer, or other tumours of the bladder. But mostly having a wide-spread clinical significance in relation to many *different* diseases, which must be investigated as the *causes* of organic urinary deposits, their further consideration belongs properly to other works. The best account of these deposits, with which I am acquainted, is to be found in the treatise by Dr. W. Roberts on "Urinary and Renal Diseases," third edition. The reader will there learn all that is practically important with regard to those more rare urinary diseases—"Endemic Hæmaturia," "Hæmatinuria," and "Chylous Urine."

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* These deposits present the characteristic structural appearances of mucus, pus, epithelial cells from the genito-urinary passages, semen, blood, casts of uriniferous tubes, various other cells, and *débris* of tissue; if stringy, coagulable by acetic acid, and consisting of a tenacious matrix with cells, some small and round, others large and flat, with oval nuclei—it is mucus; or consisting of spherical globules, not imbedded in a matrix, about $\frac{1}{1500}$th of an inch in diameter, studded with molecules and granules, and containing a double or triple nucleus on the addition of acetic acid—it is pus.

GENERAL TREATMENT.

The rational remedial treatment of any morbid condition is, essentially, the removal of the cause or causes in operation: its preventive treatment, their anticipation.

Lithic Acid, and Lithates—Treatment.—The pathological origin of lithic acid in excess is mal-assimilation, primary or secondary; or it denotes an excess of animal food over and above the wants of the system, which is accordingly expelled *in limine* from the blood through the kidneys, without having contributed to the nourishment of the body. Hygienic measures, therefore, are most important. A reduced proportion of animal food is obviously the leading curative measure, and active exercise daily to increase the elimination of any excess is equally necessary.

No remedial measures are at present known for *directly* correcting mal-assimilation in respect to lithic acid or other products. The effect of increased bodily exercise may be to increase the destructive metamorphosis of the highly nitrogenous textures, *i.e.* muscle, and thus directly increase the production of lithic acid; but this may also react beneficially in subsequently correcting the mal-assimilation.

Lithic acid passing off in the urine as lithate of ammonia is liable to be decomposed by the action of any free acid present in the urine; and lithic acid itself being insoluble appears as a deposit of reddish-yellow sand, consisting of crystals, which may aggregate and form a calculus. Hence the administration of *alkalies* to *neutralize* the acidity of the urine is indicated, of which bicarbonate of potash is, perhaps, the best for oft-repeated use. Other alkalies employed for this purpose are the bicarbonate of soda, as "Vichy water," the acetates, tartrates, and citrates of soda and potash, phosphates of soda and ammonia, and borates of soda and potash. Conversely, the *removal* of any source of *acidity* is also indicated; but this refers again to hygienic considerations. With regard to food, the vegetable acids, or that which will form them, as sugar or starch in the food, should, in Dr. Bence Jones's opinion, be prohibited. On the other hand, free perspiration to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Warm clothing, warm bathing, friction with horsehair gloves and belt—an excellent skin stimulant—and diaphoretics, may thus prove most efficacious.

Lithate of ammonia being soluble in urine at the temperature of the body, its solution is secured, provided only that fluid be not overcharged. But dilution of the urine will best prevent supersaturation and deposit. The free use of aqueous drinks or soda-water is calculated to fulfil this indication, and thus probably prevent the formation of a lithate of ammonia calculus. Diuretics, which increase the secretion, will also aid the dilution of urine, and, moreover, tend to eliminate lithic acid or lithates from the system. The wine of colchicum, in doses of ten minims and upwards three times a day, prescribed with the carbonate of potash to keep the lithic acid in combination, the resulting lithates themselves being further held in solution by the administration of diluents, may together carry off both, and soothe the irritability of the bladder which accompanies their discharge. Saline aperients seem to contribute to this desirable result. Any prolonged subjection to such a course of elimination, requires also the simultaneous action of small doses of blue pill, apparently to maintain the proportionate secretion of bile, which otherwise being retained as compared with the secretion of urine, would disturb the relative balance of their constituents in the blood.

Preventive Treatment recognises the same rules with regard to food and exercise; alkalies also occasionally to intercept the deposit of lithic acid; and dilution to secure the solution of lithates.

Urea, excess in Urine—Treatment.—It should be remembered that urea—like uric acid, from which it may be derived—is produced, physiologically in the system, by the destructive metamorphosis of the highly nitrogenous textures, *i.e.* muscle. Nitrogenous food is also, perhaps, a direct source of urea, and is assuredly followed by a rapid and very considerably increased production of this constituent of the urine. Its pathological origin is apparently similar; an excess being produced in connection with febrile conditions, and a deficiency in those of an opposite character. Consequently, the indications of curative treatment would appear to be; to lessen the daily toil and harass, which are well known to be associated with ureal diabetes, and, still guided by pathology, to reduce the supply of animal food. But this latter indication is not confirmed by experience. It is found necessary to repair the system by a generous diet, aided by tonics and alcoholic stimulants; the latter seeming to supply a material which readily oxidates, and thus protects the muscular tissue from premature decay, with that excessive production of urea which rapidly runs off through the kidneys and incessantly irritates the bladder. The quantity of urine, and thence the frequency and urgency of micturition, may be reduced by opium, which tends also to soothe the general nervous excitement that accompanies exhaustion of mind and body.

Preventive Treatment is necessarily guided by similar considerations, only with an anticipatory application.

Phosphoric Acid, and Phosphates—Treatment.—Guided by its pathological origin, an excess of phosphoric acid, in combination with alkaline or earthy bases, suggests, primarily, the endeavour to arrest, if possible, that destructive metamorphosis of nerve tissue, which generates phosphoric acid in abnormal quantity. Consequently, temporary freedom, at least from all anxiety and corroding care—in short, mental relaxation—is primarily imperative. But the phosphoric diathesis is encouraged by vegetable food. A more animal diet, therefore, with beer and wine, is scarcely less imperative.

Deposition of the Phosphates—phosphatic urine, implying, as it does, an alkaline state of this fluid, suggests the use of mineral acids. The nitric and nitro-muriatic acids diluted are perhaps the most useful ; although it must be confessed that the influence of any mineral acids on alkalinity of the urine is but slight. They are generally combined with vegetable tonics, as cinchona, and with apparent advantage. Opium also will aid in restoring acidity to the urine, besides subduing nervous excitement. Benzoic acid has been highly recommended, it being converted into hippuric acid during its passage through the system. The earthy phosphates, *i.e.* of lime and magnesia, may thus be held in solution and become invisible ; the alkaline phosphates, *i.e.* of soda and potash, never appearing. But the deposition of the former is effected by an excess of *fixed alkali,*—soda or potash in the urine. Another occasion of phosphatic urine, is an inflammatory state of the urinary mucous membrane, with the secretion of mucus, which acting apparently as a ferment, induces the decomposition of urea and liberation of carbonate of ammonia—a *volatile* alkali. The urine then becoming alkaline, deposits the triple phosphate of ammonia and magnesia with phosphate of lime. Alkalies, however, have been recommended by Dr. Owen Rees, with the view of reducing the acidity of the urine as secreted; thus preventing its irritating the mucous membrane of the bladder, less mucus is secreted, and the urine in the bladder actually becomes more acid.

Preventive Treatment is determined by precisely the same considerations respecting the generation of phosphoric acid in excess, and thence the formation of phosphates in excess; and also respecting the deposition of (earthy) phosphates in the urine, whether by fixed or volatile alkali.

Oxalic Acid, and Oxalates—Treatment.—Considering the certain pathological origin of oxalic acid, in excess, —by the primary mal-assimilation of sugar and sugar-forming food, such food is contra-indicated. Every species of vegetable food is questionable; and those which contain oxalic acid, *e.g.* rhubarb, sorrel, onions, and tomato, or certain medicines, *e.g.* alkaline salts with a vegetable acid, are unquestionably forbidden. Considering also the probable production of this acid, in excess, by the destructive metamorphosis of the nitrogenous tissues in secondary mal-assimilation, and its association with, or derivation from, lithic acid, a nitrogenous diet would seem to be contra-indicated. Nevertheless, experience shows that animal food, with brandy-and-water instead of beer or wine, form a suitable diet; but the water should be distilled, to deprive it of lime, with which the oxalic acid otherwise combining would lead to the formation of a urinary calculus.

Appropriate medicinal treatment will aid regimen. The mineral acids are efficacious, particularly hydrochloric and nitro-muriatic acids, in conjunction with bitters. They were recommended by Dr. Prout to be taken daily for about a month, or until lithic acid, or lithates, reappeared in the urine. By adopting, said he, such a course of acids three or four times in the year, and by a carefully regulated diet, I have seen this diathesis gradually subdued, and at length removed altogether. Irritability of the bladder, in connection therewith, is not unfrequently subdued by the compound tincture of camphor; indeed, Dr. Bence Jones speaks of this remedy as having thus proved " very useful."

The association of oxalate of lime with uric acid in the urine, requires the anomalous administration of both acids and alkalies. In such cases, supposing the deposit of oxalate to be considerable and persistent, Dr. Hassall suggests that it should be treated in the first instance. If the uric acid deposit be constant and in large quantity, alkalies and acids may sometimes be administered with advantage alternately.

Preventive Treatment will consist in the avoidance of those articles of food which are apt to produce or actually contain oxalic acid, and in the observance of the suitable diet. Conjointly, the precautionary use of the appropriate medicinal measures, occasionally.

Sulphuric Acid—Treatment.—Animal and vegetable food having, apparently, equal influence in producing an excess of sulphates in the urine, no distinction can be drawn favourable to either kind of diet, as a remedial agent. But as sulphur is disengaged by the destructive metamorphosis of the nitrogenous tissues chiefly, and subsequently, by oxidation, is converted into sulphuric acid, active exercise, which increases both these changes, is contra-indicated. Repose, and the requisite remedial measures for subduing febrile excitement, are, perhaps, the general indications to be fulfilled. Eliminative treatment would, of course, be curative, by removing the excess of sulphuric acid from the system; but the present state of knowledge in this respect is here, as with regard to other blood-conditions, too unsettled for practical purposes.

Preventive Treatment consists in the anticipation and avoidance of the causative conditions above alluded to.

Hippuric Acid—Treatment.—This highly carbonaceous acid is produced in excess, either by vegetable food, itself too rich in carbon, or by medicine containing benzoic acid; perhaps also by the destructive metamorphosis of nitrogenous tissue, in secondary mal-assimilation; or by defective elimination of carbon through the liver, lungs, or skin. But little is known respecting remedial measures. The substitution of nitrogenous food, increased exercise, and the administration of medicines to increase the secretion of bile and sweat, would seem to be the most hopeful.

Preventive Treatment should be guided by similar considerations.

Lactic Acid—Treatment.—The pathological origin of this acid, in excess, is obscure. Food abounding with lactic acid, introduced by primary assimilation, is undoubtedly one source. Of such kinds of food are, milk and vegetables which have become sour, and sugar or amylaceous food which may be converted into lactic acid. But an excess would also seem to arise, in some cases, from the destructive metamorphosis of muscular tissue in secondary mal-assimilation; that tissue everywhere abounding with lactic acid. Mal-excretion through the skin is another alleged cause; the sweat, it is said, containing lactic acid. Hence the imputed pathological origin of rheumatism. Defective respiration is also an apparent cause; lactic acid by oxidation being readily converted into carbonic acid.

Taking these facts and opinions into consideration, the indications of treatment are: to correct any error of diet, to moderate bodily exertion, to maintain or increase the functions of the skin by warm clothing; and to render the respiration more active, by daily exercise, when the excess of lactic acid arises apparently from an opposite condition, in this respect.

Preventive Treatment, as usual, consists in the anticipatory observance of the curative indications.

Chlorides—Treatment.—Introduced into the system by most articles of food in the course of primary assimilation, and disengaged from the tissues by destructive metamorphosis in secondary assimilation, an excess of chlorides in the blood and urine proceeds either from the food, or increased transformation of the textures. Vegetable food in general contains a much larger relative amount of the chlorides of sodium and potassium than animal food; and the component proportion of these salts in the various tissues of the body, is also different and variable. Exercise of body and mind, as affecting chiefly the muscular and nervous systems, increases the chlorides in the urine. The remedial indications are obvious; an increased proportion of animal food, and rest.

Preventive Treatment is analogous, but anticipatory.

Sugar in Urine—Treatment.—This abnormal constituent of the urine may proceed, perhaps, from various sources; mal-assimilation—primary or secondary; but chiefly, from imperfect oxidation and destruction of the sugar-glucose produced in the liver, itself transformed glucogen, also produced in that organ. This, which is Bernard's theory, as founded on experimental observations, is disputed by Dr. Pavy, whose observations led him to regard the transformation of glucogen ("hepatine") principally as a *post-mortem* change; but this, again, is denied by Dr. Harley, whose investigations may, therefore, be regarded as indirectly supporting the views of Bernard.

The imperfect oxidation of sugar is not apparently connected with deficient respiration.

Besides this pathological origin of diabetes mellitus, there is also the accidental origin from injury to the medulla oblongata, and floor of the fourth ventricle, and to the sympathetic system of nerves.

Bearing in mind the pathological origin of this disease, the indications of treatment relate to diet rather than medicine. No known medicinal measures have hitherto proved essentially efficacious; but the disease can be controlled, and for an unlimited period, by an appropriate diet.

The rule to be observed is,—a scrupulous avoidance of every kind of food containing sugar, or which can be converted into sugar. Rigorous abstinence is not equally imperative in every case, yet the indication is the same.

Animal food, therefore—including fish of all kinds, and eggs—is quite unobjectionable; while of vegetable food, the choice is restricted to greens, bran-bread or cake, and such articles as do not belong to the saccharine class of aliments. Of liquids, brandy-and-water, tea and coffee, are safe.

The diabetic bill of fare does not allow of much variety, and constant self-denial is required to keep within its bounds. Nevertheless, certain indulgences may be granted with impunity; and so far as the personal experience of *one* diabetic patient in particular affords adequate information for the guidance of others, Mr. Camplin's observations* respecting himself are valuable and encouraging.

Genoa macaroni proved to be one of the best substitutes for the bran-cake. Milk need not be forbidden. Cruciferous vegetables afford many agreeable varieties; cabbage, cauliflowers, broccoli, Brussels sprouts, etc.; sea-kale and spinach are quite harmless; onions may be permitted, and in most cases turnips. Lettuces agreed when eaten sparingly with oil and vinegar. Tea is preferable to coffee, and with it milk may be taken freely, cream only in small quantity. Cocoa is allowable if prepared from the "nibs," not that which is sold in cakes or powder. Pale French brandy should be taken, but only in measured quantities, say a table-spoonful with water. Wines are better excluded, excepting claret, which is a most suitable beverage.

Other hygienic means were very advantageous. Sponging with tepid water, followed by friction, proved highly salutary; so also sponging with cold salt water in summer, and an occasional warm bath in the winter.

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* "Med. Chir. Trans.," vol. xxxviii.

Warm clothing, a leather waistcoat, and gutta-percha soles to the boots in winter, appear equally important. Change of air and occupation were so favourable, that wheaten bread was substituted for the bran-cake during the period of relaxation.

A few words respecting medicinal treatment will suffice. Free perspiration affords some relief to the diuresis. Besides, therefore, the sudorific appliances just alluded to, the salts of ammonia are serviceable; the sesquicarbonate being an exception; at least it was so in Mr. Camplin's case. Citrate of ammonia, combined with citrate of iron, was useful. Bitters and alkalies were very beneficial. Opiates are valuable in some cases as a temporary means of checking the secretion of urine, and allaying irritability of the bladder.

Preventive Treatment.—Such also are the preventive measures—dietetic chiefly, hygienic and medicinal subserviently—by the early and patient employment of which diabetes may be kept in subjection, and for an unlimited period. It was thus that Mr. Camplin not only rescued himself from a deplorable state of health, but was preserved from the ever-threatening recurrence of this disease during a period of no less than fourteen years.

Cod-liver oil in large quantities, seven or eight ounces daily, is highly recommended by Dr. Bence Jones, in cases of considerable emaciation.*

Albumen in Urine.—Treatment of Bright's disease.—The retention of urea and water in the blood, with the discharge of albumen in the urine; and subsequently the proportionate exchange of water for albumen in this secretion, while the retention of urea in the blood progressively increases: these are the changes in the relation of the blood and urine, which are essentially of therapeutic importance. Nutriment in its best form—albumen—is incessantly draining away from the blood; while effete and noxious matter—urea—representing the decay of the textures, is constantly retained; thus conceding the powers of life to the dominion of death. Besides the symptoms incident to this double process of destruction by starvation and blood-poisoning—both of which are faithfully represented by the condition of the urine—general dropsy supervenes, owing to the retention of the water, which infiltrating the cellular texture throughout the body, presents this additional symptom.

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* "Stomach and Renal Diseases." Case p. 122.

Structural and permanent changes in the kidney are the immediate causes in operation;—congestion, followed by pale interstitial effusion, with desquamation and damage of the tubuli uriniferi; fatty, or waxy (amyloid) degeneration of the effused matter; or its absorption and contraction, constituting the so-called granular degeneration of the kidney, which becomes small and withered; with, in either way, irreparable destruction of the organ.

Remembering this abstract of the pathology of Bright's disease, the primary indications of treatment are, to reverse, if possible, the relative conditions of the blood and urine, and thus restore the condition of health.

Cupping or blisters on the loins tends to remove the renal congestion; but beyond thus aiming at the root of the disease, the perilous state of the kidneys forbids any direct attempt to restore their function.

Subsequently, diuretics may be tolerated, and then prove serviceable. Digitalis, squills, or the tincture of cantharides, cautiously administered, are, perhaps, the most efficacious. The pill originally prescribed by the late Dr. Baillie is an admirable formula. It consists of powdered digitalis, half a grain, and squills, one grain, combined with three grains of blue pill; to be taken two or three times a day.

Palliative treatment will have for its object the discharge of water, which has accumulated in the system by other channels than the kidneys; *i.e.* through the bowels and skin. Hence, hydragogue cathartics, *e.g.* elaterium, croton oil, gamboge, jalap with cream of tartar; and diaphoretics, *e.g.* citrate of ammonia, the compound powdered ipecacuanha (Dover's powder), and hot-air or sweating baths; are singly, conjointly, or in succession, often remarkably useful and comforting.

Irritability of the bladder ceases as the natural constitution of the urinary secretion is restored; but the last-named medicine—Dover's powder—will also be conducive to this result, besides having a special action on the skin.

A generous diet, consisting of an increased proportion of albuminous food, as in the form of eggs, is especially necessary in the chronic disease, to replace the albumen which has been lost, and is still passing away; with tonics also to support the circulation. The preparations of bark are thus effectual, but those of iron more so, for in no disease, perhaps, are the red corpuscles of the blood so reduced.

Further details respecting remedial treatment belong rather to special works on this disease.

Preventive Treatment has reference rather to the *causes* of that primary alteration of renal structure, whence the pathology of the blood and urine proceed. Those causes are preventible, in most instances. Scarlatina is an occasional cause; rarely, however, a productive one, unless brought into operation by cold. After scarlatina has run its course, the residue of poison remaining in the blood appears to be naturally expelled by the kidneys, thus imposing extra functional duty on these organs; yet they generally fulfil their appointed task, unless when in this state of congestion, bordering on inflammatory excitement, exposure of the body to *cold* should further impose an additional and intolerable burden. Then, under the pressure of *extreme* congestion, albumen is filtered off, urea retained, and fibrile dropsy supervenes. This *additional* strain on the excretory power of the kidneys, and its results, are obviously preventible. So also the more prevalent intemperate use of spirituous liquors, entails extra work on the kidneys; but even this strain may be borne for years with impunity, although a hazardous experiment. Exposure to cold, however, becomes intolerable; it provokes albuminuria.

Such is the usual etiology of this disease, as originally investigated by Bright,* and which the experience of other observers has since confirmed. That

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* "Reports of Medical Cases selected with a view of illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy," 1827, vol. i. p. 3.

"intemperance seems its most usual source, and exposure to cold the most common cause of its development."*

Bile in Urine—Treatment of Jaundice.—The retention of bile in the blood, and thence its effect on the system at large—of which the escape of biliary colouring matter in the urine is symptomatic—is the pathological condition of therapeutic importance. But this again has reference to the structural conditions of the liver or adjacent organs, by which such retention is effected. These causative conditions are—either mechanical, by obstruction in the ducts, or externally, to the free flow of bile into the duodenum, thus permitting the absorption of the bile imprisoned; or, some structural disease of the liver—arrest of secretion being then the immediate cause in operation, thus precluding the elimination of biliary constituents from the blood. Without any structural disease of the liver itself, arrest of its secretion may also be caused by various morbid states of the blood or of the nervous system, which, severally, paralyzing the function of this organ, induce jaundice.

The indications of treatment which may be gathered from the pathology of jaundice are of different practical significance, and hopefulness. If the retention of bile be due to some mechanical obstruction only, that causative condition may cease, spontaneously. An impacted gall-stone will most probably pass, in the course of time; or the pressure externally, of any adjacent organ enlarged by disease, may itself be relieved, from time to time. Repeated opiates, or the warm bath, will also tend to soothe and relax spasm, in the one case; and an accidental turn in the course of the disease, may bring relief in the other. But with structural disease of the liver itself, remedial measures become necessary, yet the result is less hopeful. An appeal to the secretory power of the liver may have a satisfactory response; and thus the administration of the cholagogue purgatives, large doses of blue pill or taraxacum, with salines to unload the portal circulation, may be advisable. Arrest of secretion by the influence of various blood-poisons, or powerful mental emotions, or the shock of bodily injury, affecting the nervous system, are cases scarcely within the reach of medicine. Thus, jaundice arising, occasionally, from pyæmic infection of the blood, from poisoned wounds, and from various fevers, subsides only as the morbific matters in operation are eliminated through other channels of excretion.

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* "Guy's Hosp. Rep.," 1836, vol. i.: Cases and Obs. illustrative of Renal Disease, accompanied with the secretion of Albuminous Urine, p. 339.

Preventive Treatment.—The appropriate preventive measures with regard to each of the *blood*-diseases, the causes and treatment of which we have now considered, are at once suggested by reference to the causes themselves.

Temperature is the main question to be considered in reference to the prevention of *jaundice.* Not that other etiological conditions are unimportant, but they are for the most part beyond our control.

A hot climate *predisposes* to jaundice by enfeebling the circulation and inducing congestion of the liver. It is probable also that diminished oxygenation of the blood, through habitually breathing a hot atmosphere, aids this effect on Europeans, prior to their acclimatization. Hydro-carbonaceous matter, ordinarily eliminated by the lungs, accumulates in the blood, and the liver becomes overtaxed; a burden increased by indulgence in stimulating liquors, especially malt beverages, which, abounding with hydro-carbonaceous matter, fall heavily on this organ, and further tax its functional power beyond endurance.

Such being the predisposing influences of high temperature, any change of temperature approaching to cold is the *immediate* or exciting cause of jaundice. In *every* case, Sir Ranald Martin affirms,* that he has seen in England amongst those who have returned from India, cold has been the immediate cause of this disease. Taking seventy-two cases of icterus typhoides, by Lebert, one-third occurred in November and December.

The preventive measures suggested by these observations are plain. They are most important to persons about to visit any tropical climate. Although unavoidably subjected to the physiological influences of heat, certain precautions are available. Prudent moderation in the use of stimulating beverages, and the careful regulation of clothing, should be rigidly observed. Besides adequate protection against the vicissitudes of external temperature, the cautious indulgence of cold drinks or iced beverages is an injunction not to be forgotten. On returning home, after residing for some time in a tropical climate, it is advisable, if possible, to pass the ensuing winter in a more even climate than that of England. And when residing again in this country, the continued observance of these precautions, especially as regards vicissitudes of temperature, will prove the most efficacious preventive measures.

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* "Influence of Tropical Climates in producing the Acute Endemic Diseases of Europeans," ed. 2.

URINARY CALCULI.

Urinary calculus, or stone, signifies a concretion of one or more of the constituents of the urine, forming a hard mass.

Origin.—Any such concretion originates from the precipitation of the component urinary constituents, as urinary deposits, in consequence of a loss of solvent capacity in the water of the urine. But this disturbance of solvent capacity may arise in either of three ways: (*a*) by an excess of any substance for the water to dissolve; (*b*) by a deficiency of water as the solvent; or (*c*) by the presence or absence of some third substance. Thus, then, different analyses of the urine occur in some part of the renal apparatus—kidneys or bladder,—precipitating urinary deposits.

Production of Calculus.—The formation of a calculus may occur in either of two ways: (1) The deposit may aggregate from a focus of its own substance; (2) or around a foreign body, as a distinct *nucleus*, the more frequent mode; in either way forming a calculus.

In the former mode of production, aggregation depends on (*a*) an excess of insoluble constituents, and thence their *immediate* precipitation, *e.g.*, in the forms of uric acid, urate, and oxalate concretions; or (*b*) *stagnation* of urine in the bladder, in connection with paralysis, chronic cystitis, and hypertrophy of the organ, enlargement of the prostate, or stricture of the urethra, as causative conditions of retention of urine, *e.g.*, in the formation of phosphatic calculi.

The *nucleus*, when distinct, is some foreign body; a small clot of blood, or mucus, derived from the urinary organs in which the calculus originated; or it may be some extraneous foreign body, introduced into the bladder through the urethra, or by wound or ulceration of the organ.

The *constituents* of a calculus are fixed, in the state of aggregation, by some kind of *cement*, apparently animal matter; as mucus, fibrine, or fatty matter; possibly blood, epithelium, or even pus.

The *seat* of origin, in the urinary organs, has already been adverted to; commonly, it is in the kidney or bladder; occasionally, however, in the urethra, as the dilatation behind a stricture; and thus a calculus is designated *renal*, or *vesical*, possibly *urethral*. Generally, a urinary calculus originates in the kidney, and subsequently descends, as a small stone, into the bladder, where it increases by further concretion.

Urinary calculus differs in its physical characters and chemical composition; representing different classes and species of urinary calculi.

Chemical Composition.—Urinary calculi, in regard to their essential constituents, may be divided into two classes, a third class representing the more rare forms: (1) calculi consisting of uric acid and urate of ammonia, with their varieties, the oxalate of lime, uric or xanthic oxide, and cystic oxide or cystine; (2) phosphatic calculi in all their varieties, as phosphate of ammonia and magnesia or triple phosphate, phosphate of lime, and mixed phosphates of lime, magnesia, and ammonia, or the fusible calculus; (3) the fibrinous uro-stealith, carbonate of lime, and silicious calculi.

Physically considered, urinary calculus varies in point of size, shape, weight, colour, odour, consistence, appearance on section, and number. The *size* is extremely variable; from that of a hemp-seed, pea, nut, or almond, to a cricket ball, and occupying the whole cavity of the thickened bladder. Of large-sized calculi, one may be seen in the Museum of the Royal College of Surgeons, and another in the valuable collection of the Norfolk and Norwich Hospital Museum. That in the College collection measures 16 inches around its long axis, and 14 inches around its short axis; it weighs 44 ounces.

The *shape* also varies remarkably, and principally according to the situation and composition of the stone. Renal calculus is irregular, and often moulded to the form of the calices and pelvis of the kidney; in the ureter, a stone is generally cylindrical; the vesical is more uniformly of a flattened ovoid shape, or globular; while the prostatic is pear-shaped, or singularly faceted. In relation to composition; uric acid and urate of ammonia calculi are usually smooth and regular; the oxalates tuberculated like a mulberry, hence the common name of this calculus; the phosphatic may be smooth or regular, or irregularly contorted. The *weight* depends more on the composition than the size of the stone; the phosphatic being very light, the oxalates very heavy, and uric acid or urates between the two. The average weight is an ounce; but extremes have been met with—in a stone of 10 grs. taken from a boy; another of nearly 6 ounces, removed by Sir A. Cooper; and another of 32 ounces, in the Museum of Trinity College, Cambridge. Of heavy calculi not removed, Deschamps saw one that weighed 51 ounces; and Morand, one weighing 6 lbs.—the heaviest on record. The *colour* of a calculus represents only the chemical nature of the surface or external crust of deposit; the interior is often very different. A white surface signifies a phosphatic crust; a cinder-grey, that of urate of ammonia; a yellow, pale brown, or brown, the uric acid; cinnamon-brown, the uric or xanthic oxide; a mahogany brown, brownish or blackish green, the oxalate of lime; a grey-greenish or slate-colour, the cystic oxide. The *odour* of a recently extracted calculus is sometimes peculiar. Phosphatic calculus may be ammoniacal, and oxalate of lime, on section, is said to emit a faint odour of semen. An aromatic smell, as of castor or musk, is sometimes perceptible. The *consistence* varies from that of mortar or sand to that of granite. But this will depend on the chemical nature of the calculus and on the intermixture of organic matter, or moisture in a recently extracted stone. Phosphatic calculus is generally soft; the uric acid hard; and the oxalates very hard. The crust is usually softer than the interior, and the nucleus has the densest consistence.

Section of a calculus presents a certain *structure;* a distinct nucleus, in most species, and the surrounding concretion, which has an external crust, more or less distinct. The concretion-substance is commonly disposed in concentric layers or laminæ, and sometimes shows radiating lines from the centre to the circumference of the stone; or it may be continuous, having no visible arrangement. The former appearance corresponds, apparently, to successively active periods of urinary deposit, as depending on varying states of the urine; while the latter appearance would indicate the result of an uninterrupted deposit.

Simple calculus consists of only one chemical constituent, and thus presents a section uniform in colour and consistence; *compound* calculus consists of different constituents, presenting a section of varying appearance at different depths. Lamination may occur in the formation of both a simple and a compound calculus. In the latter, the deposition of different matter may have a regular alternation, forming an *alternating* calculus.

The *nucleus* varies, as already said, in its nature, and also in its situation, number, and connection with the surrounding concretion. Thus commonly central, or nearly so, it may be very eccentric, as in some renal calculi; usually single, there may be two or several nuclei, as distinct centres of concentric deposition; and usually connected and fixed, the nucleus may be isolated and loose, owing apparently to a layer of blood or mucus having first gathered around it, followed by the concretion, while the organic matter has dried and disintegrated, isolating the nucleus. Lastly, the latter may itself have disappeared, leaving a central cavity; this result ensuing, probably, when the nucleus was organic matter which has undergone disintegration.

The *differential* Physical characters of the various species of calculi are indicated in Table I.

I. TABLE INDICATING THE PHYSICAL CHARACTERS OF URINARY CALCULI.

Arranged in the Order of their Chemical Affinity with regard to Tests. (See TABLE II.)

	COLOUR.	SHAPE.	SIZE.	WEIGHT.	CONSISTENCE.	SECTION.
Uric or lithic acid.	Brown, light, or dark.	Ovoid and flattened.	Pea to orange.	Heavy.	Hard; fractured into sharp angular fragments and crystalline.	Concentric laminæ, radiating lines from nucleus.
Urate of ammonia.	Clay or slate, or reddish brown.	Ovoid, smooth, or tuberculated.	Small.	—	Fracture earthy (not crystalline).	Homogeneous.
Uric or xanthic oxide; very rare.	Cinnamon.	Flattened.	Small, as pullet's egg.	—	Hard; fracture not crystalline.	Laminated.
Cystic oxide or cystine; rare.	Yellowish brown; grey-green or slate after long exposure; and waxy, glistening, slightly transparent.	Round, smooth, or tuberculated.	Small.	—	Soft and pulverescent; fracture crystalline; powder is white.	Homogeneous, with imperfect radiation.
Fibrinous calculus; rare.	Yellow.	Pea-shaped.	—	—	Fracture vitreous and lustrous; like yellow wax.	
Uro-stealith; very rare.	Resinous or fatty bodies.	—	Small.			
Blood-calculus; very rare.	Disintegrated blood-corpuscles, with phosphate of lime; black colour.	—	From coriander-seed to horse-bean.	—	Friable; fracture amorphous.	Amorphous; dark rusty.

Carbonate of lime; very rare.	White or ash.	Spherical or irregular.	Pea to nut, or larger.	—	Soft and friable; or very hard; fracture amorphous.	No concentric laminæ, or imperfectly lamellar.
Oxalate of lime, or mulberry calculus.	Dark brown, or blackish-green.	Spheroidal, tuberculated, angular, or spinous; rarely smooth.	Marble to horse-chestnut.	Very heavy	Very hard; fracture crystalline.	Imperfectly laminated in irregular waved lines.
Varieties; rare.						
Hemp-seed calculus.						
Crystalline.	White-brown.					
Ditto.	Pure white.					
Phosphate of ammonia and magnesia.—Triple phosphate.	White or grey.	Irregular; somewhat spiculated.	Large probably.	—	Friable fracture, perhaps crystalline.	Imperfectly laminated.
Phosphate of lime; renal origin.	Pale brown.	Spheroidal and smooth.	Small.	—	Friable.	Laminated.
Vesical origin; bone-earth phosphate.	—	Irregular masses, or granular semi-crystalline powder in tenacious mucus.				
Phosphate of magnesia and ammonia, with phosphate of lime.—Mixed phosphates. — Fusible calculus.	White grey, or dull yellow.	Very irregular; moulded to locality; sometimes globular or ovoid; or in pieces, cubic or tetrahedral	Large probably.	—	Very friable or pulverescent, or soft, like moist chalk.	Concentric laminæ, or semi-crystalline, or amorphous, according to proportion of phosphates.
Silicious calculus, only in other calculi.						

The *number* of calculi varies chiefly according to the seat of the stone. In the bladder, usually, there is only one; in the kidney, two or more; and in the prostate, several. Vesical calculi are, however, sometimes numerous; two to six or eight are not very uncommon; and instances are on record of 117; 142 about the size of marbles, were removed by Sir A. Cooper; 307, 678, and even 1000 have been found; the latter number having been extracted by Dr. Physick from an American judge. This number is the largest on record; the stones varied in size from partridge-shot to a bean.

The *relative frequency* of different calculi varies in different countries. Thus, comparing India and England: (1) In Bombay, the proportion of oxalate of lime calculus is about twice that in England, taking standard collections of calculi, for comparison, in both countries. (2) The proportion of uric acid calculi is considerably less in India than in England; in the former country, urate of ammonia calculi are somewhat more frequent than uric acid calculi, and conversely in England. (3) The proportion of phosphatic calculi is much less in India than in England, owing to the rarity of the mixed phosphates in the former country. In making these estimates, the calculi compared relate to the composition of the nucleus, or the entire substance of the concretions.

Examination of Urinary Calculi.—The *appliances* requsite for the examination of calculi are few and simple: a platinum spoon, or piece of platinum foil, a spirit-lamp, and sometimes the aid of a blow-pipe; test-tubes, and watch-glasses, with the acids—nitric and hydrochloric, and the alkalies—carbonate of potash and oxalate of ammonia. Certain *special* reagents will be noticed in the Table.

The *order of procedure* is, first to test a bit of the calculus in powder, by *heat*, and thus refer it to one of the two divisions: calculi combustible and destroyed by heat, leaving only a very little residue; or, calculi non-combustible, and not destroyed by heat, leaving a considerable residue. In the former case, the original powder is to be tested for uric acid, urate of ammonia, uric oxide, or cystic oxide; in the latter case, it is to be tested for (carbonate of lime) oxalate of lime, ammoniaco-magnesian, or triple, phosphate, phosphate of lime, or the mixed phosphates. Next, the *mineral acid* test is to be applied; if a combustible calculus, dilute nitric acid should be used; if a non-combustible calculus, dilute hydrochloric acid is preferable. Then, the *alkaline* test must be applied. Lastly, the *special tests* may be resorted to.

Calculi will be conveniently described in the order of their chemical affinity, with relation to *Tests.*

(1) *Uric, or Lithic acid Calculus.*—The most common of all calculi, is that consisting of lithic acid. It was discovered by Scheele in 1776. Its colour is generally light brown, varying, however, from pale brown to dark brown; and sometimes whitish on the surface owing to its having become coated with amorphous urate of ammonia, or with phosphate of lime. The shape is usually ovoid, and somewhat flattened; the surface smooth, or beset with small tubercles, so as to resemble the surface of oxalate of lime calculus; the size varies

from that of a pea to an orange; and its consistence is hard in proportion to the purity of the calculus; sometimes emitting a ringing sound on percussion, and breaking up into sharp angular fragments. The calculus is composed of concentric laminæ, and presents lines or fibres radiating from the centre to the circumference of the stone; both these appearances are marked in proportion to the purity of the calculus, and determine the lines of fracture when the stone is broken. The nucleus may be quite white, although consisting of pure uric acid, owing, as Dr. G. O. Rees has shown, to the absence of colouring matter. The fracture is crystalline. *Tests :*—Combustible, and destroyed by heat; turned red by nitric acid, forming a murexide; soluble in carbonate of potash, evolving *no* ammonia.

(2) *Urate of Ammonia Calculus.*—This is not a common form of calculus, urate of ammonia being soluble in warm urine; and it is generally confined to children. It was discovered by Fourcroy and Vauquelin, in 1798. The colour of this calculus is that of clay or slate, and pretty characteristic, but less so when inclining to red or brown; it has an ovoid shape, and a smooth or slightly tuberculated surface, and is of small size; the section is homogeneous, seldom presenting a distinctly concentric laminated condition. Fracture is earthy—not crystalline. *Tests :*—Combustible, and destroyed by heat; turned red by nitric acid, forming a murexide; soluble in carbonate of potash, evolving ammonia.

Urates of *Soda* or *Lime* are not found as calculi; these urates are mixed with urate of ammonia or uric acid in compound calculi.

(3) *Uric or Xanthic Oxide Calculus.*—A very rare calculus—four specimens only have been recorded. It was discovered by Dr. Marcet in 1715. The calculus has a cinnamon colour, a somewhat flattened shape and small size—resembling a flattened pullet's egg, in a stone examined by Stromeyer; its texture is hard and laminated. Fracture, not crystalline. Uric oxide bears a close relation to uric acid, and results apparently from an imperfect oxidation of the chemical material which forms uric acid. *Test* :—Combustible, and destroyed by heat, but not turned red by nitric acid; soluble in ammonia, *not* crystallizing when evaporated; insoluble in carbonate of potash.

(4) *Cystic Oxide, or Cystine Calculus.*—This also is a rare calculus, discovered by Wollaston in 1810. It has a yellowish-brown colour, approaching that of the uric acid calculus, but after long exposure, it changes to a peculiar grey-greenish or slate colour; there is also a characteristic waxy, glistening, and slightly transparent appearance. Rounded and smooth or tuberculated, and of small size, the consistence is soft and pulverescent; a section exhibits no tendency to concentric laminæ, and only very imperfect radiation. The fracture is crystalline; powder scraped with a knife is perfectly white, whether the stone be brown or green. Hereditary disposition to the formation of this calculus is strongly evinced; in 22 cases, 10 occurred in four families, and in 3 cases the subjects were brothers. Cystic oxide calculus differs from all others chemically, in containing a large proportion of sulphur—about 26 per cent. It originates in the kidney, and not in the bladder, as its

name might imply. *Tests:*—Combustible, and destroyed by heat, but not turned red by nitric acid: soluble in ammonia, crystallizing when evaporated in six-sided plates; soluble in strong caustic potash.

(5) *Fibrinous Calculus.*—Described by Dr. Marcet and Dr. Prout; this rare calculus, so called, seems to have occurred in the form of pea-shaped bodies, of a yellow colour, and consisting of dried, coagulated albuminous matter. It can scarcely be regarded as a concretion, although such masses have presented considerable lustre and a vitreous fracture; resembling yellow wax in appearance. *Tests:*—It may be distinguished from cystine, by being soluble with difficulty, in ammonia, and not crystallizing when evaporated.

(6) *Uro-Stealith Calculus.*—Another very rare pseudo-form of calculus, consisting of resin or fatty-matter. It was originally described by Heller in 1844; several small bodies of this kind having been passed by a man, aged twenty-four, who suffered from symptoms of stone. Since that time, Dr. Moore, of Dublin, has examined several specimens sent to him by Dr. Robert Adams. *Tests:*—Soluble in ether and caustic potash; insoluble in boiling water and nearly so in alcohol; when heated and melted, the odour of benzoin is emitted.

(7) *Blood Calculus*, consists apparently of disintegrated blood-corpuscles associated with phosphate of lime; it therefore represents another form of pseudo-calculus, and which is also very rare. Described by Dr. Alison, and examined by Dr. G. O. Rees; a few such calculi were found in the pelvis of the kidney of a man who died of consumption. They had a black colour, and

ranged in size from a coriander-seed to a small horse-bean; they were friable, and the fractured surface presented an amorphous, dark rusty appearance. *Tests* seem to have elicited nothing peculiar; the calculus-matter was partly combustible, and soluble in liquor potassæ.

(8) *Carbonate of Lime Calculus.*—An extremely rare form of calculus, discovered by Brugnatelli in 1819. Of a perfectly white or an ash colour, spherical or irregular, and varying in size from a pea to a nut or larger; the consistence is usually soft and friable, but sometimes very hard. Section shows no concentric laminæ, or only an imperfect lamellar structure. The texture is amorphous. Prostatic calculi consist almost entirely of carbonate of lime, as Dr. Thudichum has shown; but it is always doubtful whether the lime or the carbonic acid were in any case derived from the urine. *Tests*:—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, effervesces *before* heating; soluble in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.

(9) *Oxalate of Lime Calculus.*—This is the next most common after the uric-acid calculus. It was discovered by Wollaston in 1797, but the nature of oxalic acid deposit was long afterwards originally investigated by Dr. Golding Bird. The colour is rich mahogany-brown, or sometimes blackish-green; the shape spheroidal, and surface tuberculated, angular, or even spinous, rarely perfectly smooth; and varying in size from a marble to a horse-chestnut. This remarkable colour and external appearance have given the special name "mulberry" to the oxalate of lime calculus. Its density and weight are

great; and section shows an imperfectly laminated structure of irregular waved lines, often resembling knotted heart of oak; occasionally, a notably radiated appearance, like a series of minute needles placed side by side. The fracture is crystalline. Dr. Lionel Beale has specially traced the formation of this calculus, from an oxalate of lime concretion not larger than 1-500th of an inch; and he finds that dumb-bell crystals are first aggregated together into a small collection, in the interstices of which crystalline matter is deposited, forming a microscopic calculus.

Varieties of appearance are produced by the deposition of crystallized oxalate of lime on the surface of the calculus; sometimes as a coating of transparent octohedrons, or it may be opaque; and the calculus looks as if studded with pearl-spar. The deposition also of amorphous matter, as urates or phosphates, may fill up the intervals between the tubercles or spines, and give the whole an ovoid shape. In compound calculi, oxalate of lime deposition presents the beautiful appearance of fortification agate.

Rarer *varieties* are occasionally met with. The small, smooth, globular "hemp-seed" calculus, of a light brown colour. Also, the calculus of a white or pale brown colour, and crystalline throughout. Lastly, the pure white oxalate of lime calculus. These varieties are generally found in the kidney. *Tests*:—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, effervesces *after* heating; solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.

(10) *Phosphate of Ammonia and Magnesia—or Triple Phosphate—Calculus.*—Discovered by Wollaston in 1797, this calculus is not common. It is of a white or grey colour, irregular shape and somewhat spiculated, may attain a large size, and has a friable consistence; is imperfectly laminated, and the fracture sometimes crystalline like alabaster. *Tests*:—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives a crystalline precipitate.

(11) *Phosphate of Lime Calculus*—also discovered by Wollaston in 1797—is rarely found in the bladder uncombined with other salts; and it seldom forms the nucleus of other calculi. It has a pale brown colour; spheroidal form and smooth surface; is usually small, friable and laminated. This condition of the calculus is of *renal* origin, and consists of the neutral phosphate of lime. Another condition is of *vesical* origin, and consists of bone-earth phosphate; it occurs in the shape of irregular masses resembling mortar, or a granular semi-crystalline powder, enveloped in a tenacious mucus. Phosphates form around other calculi, or foreign bodies; but they are scarcely ever succeeded by a deposit of uric acid or urate of ammonia, or of oxalate of lime. *Tests*:—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives an amorphous precipitate.

(12) *Phosphate of Lime, and Phosphate of Magnesia and Ammonia Calculus—or the Mixed Phosphates—*

Fusible Calculus.—Another discovery by Wollaston in 1797, this is the most common of the three phosphatic calculi, and represents rather more than 1 in 12 of all calculi. The calculus is of a white, grey, or dull yellow colour; generally of a very irregular shape, and moulds itself to the situation where found; sometimes globular or ovoid, sometimes in many pieces and assuming a cubic or tetrahedral form. It may attain a considerable size, and has a very friable consistence and pulverescent character, or a soft consistence, resembling moist chalk. Section shows generally a concentric lamellar structure, and sometimes shining crystals of the triple phosphate between the laminæ, or a semi-crystalline appearance. The relative proportion of the constituent phosphates varies exceedingly, and the predominance of one or the other phosphate gives peculiar characters; an abundance of triple phosphate presents a crystalline texture, while that of phosphate of lime exhibits an amorphous earthy appearance. Mixed phosphates are more commonly deposited on foreign bodies introduced into the bladder; encrusting them with white friable calculous masses. *Tests*:—Not combustible, and not destroyed by heat; soluble with hydrochloric acid, but does *not* effervesce either *before* or *after* heating; solution in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous, precipitate; without addition, easily *fusible* before the blow-pipe.

(13) *Silicious Calculus.*—As a separate concretion this calculus has not been met with; but silica has been found in other calculi by Berzelius, Vauquelin, Fourcroy, and Venables. *Tests*:—Silica is negative with regard to all

the tests for other concretions; it is *not* acted on by heat, acids, or alkalies.

The *relations* of Calculi to *Tests*, general and special, are shown in the following Table II., which represents also the *order* of chemical examination, It is enlarged from the well-known Lectures of Dr. Bence Jones on Animal Chemistry:

II. TABLE FOR EXAMINING URINARY CALCULI.

1. By Heat.	2. By Acids.	3. By Alkalies.	Nature of Calculus.	Special Tests.
Destroyed by heat.	With nitric acid, red.	Soluble in carbonate of potash, evolving *no* ammonia.	Uric acid.	Solution in caustic ammonia or potash, on the addition of an excess of acid, crystallizes in angular crystals. Not soluble in water.
		Soluble in carbonate of potash, evolving ammonia.	Urate of ammonia.	Soluble in water, when boiled. Solution in water, with a few drops of ammonia, evaporated, crystallizes in needles—microscopic.
	With nitric acid, not red.	Soluble in ammonia, *not* crystallizing when evaporated.	Uric or xanthic oxide.	Insoluble in carbonate of potash; dissolves without effervescing in nitric acid, leaving a lemon-coloured residue; soluble in strong sulphuric acid, not precipitated by dilution.
		Soluble in ammonia, crystallizing when evaporated.	Cystic oxide or cystine.	Soluble in strong caustic potash; the solution, boiled for a few moments, on the addition of a drop of dilute acetate of lead, gives sulphuret of lead.
		Soluble in ammonia with difficulty, not crystallizing.	Fibrine.	With nitric acid becomes directly yellow. Solution in caustic potash precipitable by acetic acid in amorphous form.
Not destroyed by heat.	With hydrochloric acid soluble; *before* heating, effervesces.	Solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.	Carbonate of lime.	Soluble in dilute acetic acid, with effervescence.
	With hydrochloric acid soluble; *after* heating, effervesces.	Solution in acid, when neutralized, gives a precipitate with carbonated alkalies and oxalate of ammonia.	Oxalate of lime.	Insoluble in acetic acid. Boiled with carbonate of soda, oxalate of soda is dissolved, precipitated by chloride of calcium.
	With hydrochloric acid soluble; does *not* effervesce *before* or *after* heating.	Solution in acid, with excess of ammonia, gives a crystalline precipitate.	Phosphate of ammonia and magnesia.	With half its bulk of phosphate of lime (bone earth), is very fusible before the blow-pipe.
(Not destroyed by heat.)	(With hydrochloric acid soluble; does *not* effervesce *before* or *after* heating.)	Solution in acid, with excess of ammonia, gives an amorphous precipitate.	Phosphate of lime.	With twice its bulk of phosphate of ammonia and magnesia, is very fusible before the blow-pipe.
—	—	Solution in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate.	Mixed phosphates.	Without addition, easily fusible before the blow-pipe.
Not acted on.	Not acted on.	Not acted on.	Silica.	Fused with twice its bulk of carbonate of soda, forms glass; soluble in water, precipitable by hydrochloric acid.

Causes of Urinary Calculi.—The urinary *production* of formation of calculus has already been noticed. *Predisposing* causes are here considered.

Climate and *locality* have apparently some predisposing influence. Calculus is more common in temperate than in warm and cold regions, and more especially in humid countries of moderate and changeable temperature, such as Holland, France, Germany, and England. It occurs, however, very frequently in Egypt, Isle of France, Russia, Bagdad, and both the East and West Indies. Some parts of the same country are certainly more prone to calculus-production than other parts; as particularly the county of Norfolk in this country. *Race*, it is said, has different proclivities; that calculous disorders are more common among white than dark races of men, yet stone is of very frequent occurrence among the natives of India.

Hereditary transmission is evinced in the gouty diathesis, and the production of lithic acid calculi.

Sex undoubtedly affects the relative proportion; stone is less frequent in females than males, in the proportion of 1 to 20, or 1 to 23. This remarkable disproportion is attributed mainly to the peculiar anatomical disposition of the female urethra; its comparative shortness, larger size, dilatability, and straight course, all these circumstances facilitating the passage of a small stone.

Period of Life or Age.—Stone may occur at any age; and, according to Stahl and Geyer, it occasionally exists as an intra-uterine affection. But the two extremes of life seem to be most subject; stone being met with most frequently, it is said, in young and in old people. Of 5,376 cases collected by Civiale: 1,946 occurred before the age of 10 years, 943 from 10 to 20, 460 from 20 to 30, 330 from 30 to 40, 391 from 40 to 50, 513 from 50 to 60, 577 from 60 to 70, 199 from 70 to 80, and 17 after 80 years of age. Coulson senr. has collected 3,264 cases of lithotomy: under 20 years of age, the proportion was 71·20 per cent.; between 21 and 40 years, 12·10 per cent.; between 41 and 60, 10·87 per cent.; and between 61 and 80, 5·72 per cent. Sir H. Thompson's table comprises 1,827 cases: under 20 years of age, 60·42 per cent.; between 21 and 40, 10·18 per cent.; between 41 and 60, 17·56 per cent.; and between 61 and 81, 11·83 per cent. Respecting the value of these statistics, Mr. Coulson has well remarked, that they represent the absolute number of persons affected with stone at different ages; but not as relative to the total number of persons living at the several periods of life. Thus, if all persons under 20 years were affected with a certain disease, and all persons over 70 years were affected with the same disease, the liability would be the same, although the absolute number of persons attacked would be very different. By correcting this error between absolute and relative numbers, the tables would show that children and young persons are less liable to calculous disorders than is commonly supposed; that from 20 years upwards, the tendency goes on increasing in a very remarkable manner to the end of life. Sir H. Thompson thus expresses it: "That the proportion of elderly calculous patients to the existing population at their own ages is larger than the proportion of children affected is to the number of existing children."

Habits of life have unquestionably some causative tendency. Thus, sedentary habits diminish the perspiratory secretion, and throw increased work on the kidneys; high living, and especially indulgence in various kinds of nitrogenized food, and certain beverages, supply the material for uric acid and other allied concretions, while indigestion and secondary mal-assimilation in the textures generate uric acid.

Various morbid conditions of the *urinary organs* may induce calculous formations; the presence of a foreign body especially, which solicits the precipitation and deposition of the urinary constituents around itself as a nucleus.

Other accredited causes are doubtful. Thus, the imputed influence of certain mineral waters is fallacious, none of the forms of calculi corresponding to the salts in such waters. The alleged exemption of persons in certain occupations, as soldiers and sailors, seems very doubtful.

Diagnosis of Urinary Calculi.—In relation to treatment—whether medical or surgical, and especially the former, the *species* of urinary calculus is a question of great importance.

The elements which, singly or collectively, determine the diagnosis are,—the examination of gravel or small portions of concretion passed in the urine, the accompanying condition of urine, the constitutional condition or diathesis, and the other predisposing causes already enumerated. If all this knowledge should fail to establish any positive conclusion as to the nature of a calculus, it may at least have a *negative* value, by indicating the species to which the stone is not allied, and thus indirectly guide to an appropriate treatment.

The examination of *gravel* or small portions of concretion, supplies the most exact knowledge relative to the species of calculus coexisting.

The condition of *urine* passed at the same period, affords the next most reliable ground of diagnosis. Urinary reaction and deposits are here the indications to be observed.

The *reaction* may be acid or alkaline; and the latter from fixed alkali, or from volatile alkali,—carbonate of ammonia.

(1) *Acid* reaction will indicate that the calculus is either uric acid or oxalate of lime, or a combination of both species of concretion. A *deposit* of one or other of these constituents can alone determine the particular species of calculus. Not unfrequently, either deposit alternates with the other, and then a combination of both may be inferred. The presence of either deposit in the urine for any considerable period would indicate that the external crust of the stone is of that kind; but this will fail to indicate the composition of the deeper substance.

Renal calculi contrast with vesical calculi, in being much more simple, consisting usually of only one species; while the vesical are usually compound, consisting of two or more species. This complexity increases often according to the period during which the calculus has remained in the bladder. Consequently, if the calculus originated in the kidney, but has descended into the bladder at a recent date, it will probably be *simple;*

and while an acid reaction might indicate either uric acid or oxalate of lime, the deposit will probably determine which species constitutes, in this case, the *entire* calculus.

The relatively greater *frequency* of uric acid compared with oxalate of lime calculus, is a consideration which may aid and corroborate an otherwise doubtful diagnosis; but such evidence is of much less value than that derived from examination of the urine.

Constitutional predisposition supplies a more important element in our calculation of probability. Thus the gouty diathesis will more probably be associated with uric acid than with oxalate of lime calculus.

(2) *Alkaline* urine has a widely different significance, according to the nature of the alkali. *Fixed* alkali is associated with phosphate of lime, or with carbonate of lime. Both these species of calculi are rare, and the latter extremely so. *Volatile* alkali-carbonate of ammonia is always associated with a calculus—when present—the crust, at least, of which consists of phosphate of ammonia and magnesia, with phosphate of lime, forming the mixed phosphates or fusible calculus. Yet the composition of the nucleus and body of the calculus cannot be inferred. The thickness of the crust varies according to the greater or less degree of ammoniacal reaction and odour; and this, again, will be influenced by the quantity of mucopurulent secretion, as estimated by its discharge in the urine; but the duration of this twofold condition of urine will, of course, affect the resulting proportion of the encrusting deposit. At length, however, portions of phosphatic concretion may be passed with the urine.

It is necessary to observe that the urine is ammoniacal when passed, and not as the result of decomposition, subsequently.

TREATMENT OF CALCULI.

Urinary calculi may be subjected to two kinds of treatment: medical and surgical.

Medical treatment has two objects in view; the *prevention* of the formation of a calculus, when the causative conditions predisposing thereto exist; the *removal* of a calculus, by solution, and the expulsion of its constituents through the urethra, or the solvent treatment.

Surgical treatment is restricted to the accomplishment of the latter object,—the removal of a calculus, and by means of certain operative or mechanical procedures: *lithotrity*, the removal of a stone mechanically, by crushing it in the bladder with instruments, and extraction or expulsion piecemeal of the *débris* through the urethra, or perhaps by simple dilatation of the urethra without any cutting operation; *lithotomy*, or the extraction of stone by a cutting operation.

The two kinds of treatment are here stated in the order of their relative desirability, but their practicability is nearly the reverse, surgical treatment being generally far more effectually curative. Still, however, to complete this Treatise, I shall here notice the *medical* treatment of calculi, especially from a preventive point of view; operative procedures having been already fully considered.

Preventive Treatment.—The prevention of calculous concretion implies the recognition of any such signs as may indicate a predisposition thereto, and in due time to anticipate this result. An habitual and persistent *deposit* in the urine of some one or more of the constituents of a calculus, affords the surest evidence of the probable issue. Thus persistent deposits of uric acid, urates, oxalate of lime, earthy phosphates, or cystine, as the constituents, severally, of the more common species of urinary calculi, are premonitory of their formation; but only under certain circumstances, of urinary deposit. The significant conditions are, when the deposit, as of uric acid or oxalate of lime, is found in the urine, immediately after micturition, or is deposited before it has cooled. Either appearance would indicate that the constituent of one or the other concretion is secreted with the urine. Whereas, the same appearance taking place at a subsequent period, when the urine has stood for a few hours, might be the result of after-changes. An ammoniacal condition of urine, in connection with cystitis, has always a tendency to concretion of the earthy phosphates deposited. The liability to calculous formation cannot be doubted whenever any portion of concretion has passed with the urine, or the patient has undergone an operation, lithotrity or lithotomy, for the removal of stone from the bladder.

Preventive treatment may be general, as relating to all calculi; or special, as relating to the different species of stone. The *general* indications are to prevent any concentration of urine, and its prolonged retention in the bladder. Either or both conditions would obviously have a direct causative tendency to the formation of calculous concretion. Concentration of the urine occurs mostly after fasting, some hours previous to the next meal, and during sleep; in the latter physiological state of the system also, the urine is not only scanty, but retained in the bladder for a longer period than in the day-time. And during fasting or sleep—states of the system more or less remote from the process of digestion—the urine becomes highly acid; but again more nearly alkaline after a meal, when a flow of the acid gastric juice into the stomach reduces the acidity of the blood. The recumbent posture, during sleep, was conceived by Dr. Prout to favour the accumulation of urine in the pelvis of the kidney, and thus possibly induce the formation of renal calculus.

To meet all these contingencies, an increased quantity of water or other aqueous fluid should be drunk, especially after an interval since food was taken, or at bed-time. The intervals between meals, moreover, should not be protracted, nor sleep in bed unnecessarily prolonged. Thus, a tumbler of water may be taken once or twice daily; particularly before a late dinner, and on going to bed; while, instead, perhaps, of only two meals a day, breakfast and dinner, luncheon should also be taken, at nearly equal intervals, and early rising should be enjoined. The latter precaution will be of less consequence if the individual be accustomed to wake once or twice in the night, when the bladder can be relieved of its contents.

Special Preventive Measures.—Predisposition to the formation of *uric acid* calculus may be controlled by the medicinal and dietetic measures already noticed in relation to the precipitation of this acid as a urinary deposit. Alkalies, such as the bicarbonate, acetate, or citrate of potash, in drachm doses to a tumbler of water, as a diluent, should be taken morning and evening. Vichy water or lithia water may be drunk in preference. A reduced proportion of animal or azotised food and more active exercise to carry off any excess, will also have a preventive tendency. Free perspiration, to eliminate the acids of the sweat, the retention of which would precipitate uric acid in the urine, is scarcely less important. Hence, warm clothing, warm bathing, friction of the skin by the daily morning use of Turkish towels, or horse-hair gloves and belt, are most efficacious.

Predisposition to *oxalate of lime* concretion may probably be kept in subjection by the observance of similar precautions. Aqueous drinks to prevent any supersaturated solution of the oxalate; and the avoidance of those articles of diet which contain, or perhaps generate, oxalic acid, as rhubarb, sorrel, onions, tomato, and sugar, or sugar-forming food. Animal food, with brandy and water instead of beer or wine, form a suitable diet; but no hard water should be drank; it should be distilled, to deprive it of lime. Otherwise, the lime combining with oxalic acid would induce the urinary concretion. Medicinal preventive measures may be either acids or alkalies. The mineral acids, particularly hydrochloric and nitro-muriatic acids, were strongly recommended by Dr. Prout. On the other hand, alkalies might prove serviceable, if uric acid by conversion be the source of the oxalic acid. Both acids and alkalies may be administered alternately, to combat any tendency to an association of the two species of calculous concretion.

The prevention of *phosphatic* concretions relates especially to the *earthy* phosphates, the more common constituents of such calculi. The phosphates of lime and magnesia are deposited, in connection with an ammoniacal alkaline state of the urine, as depending on mucopurulent cystitis. Concretion is apt to form around some portion of pus or mucus, or a fragment of any stone left in the bladder after lithotrity or lithotomy. Hence the corrective use of acids is indicated, and particularly by injection into the bladder, as in the treatment of chronic cystitis.

No special preventive treatment is required for *cystine* concretion, which is comparatively rare, and any tendency to which will be counteracted by the measures appropriate for uric acid calculus.

Solvent Treatment.—The removal of a calculus by *solution* is a mode of *cure* which has been attempted by either of two kinds of agents; by chemical solvent agents,—lithontriptics administered by the mouth, or by injection into the bladder; by electrolysis,—the transmission of an electric or galvanic current, for the dissolution of stone in the bladder.

(*a*) *Chemical* solvent agents comprise alkalies and acids. The former class of remedies may be employed for the removal of calculi which are soluble in alkalies, *i.e.*, uric acid, urates, and cystine; the latter class for those calculi which are soluble in acids, *i.e.*, oxalate of lime and phosphatic concretions. The mode of administration of either class of these remedies might be by the mouth, or by injection into the bladder. Practically, however, the chemical solubility of urinary calculi, and the mode of attacking them, seems to amount to this: that uric acid calculi only, and allied concretions, are soluble by alkalies, and as administered by the mouth; phosphatic calculi only by acids, and by injection of the acid solution. Oxalate of lime calculi cannot be dissolved by any known solvent agent or method of administration.

It would appear also from Dr. W. Roberts's original series of experiments and clinical observations, that *renal* calculi are more generally amenable to solvent treatment than vesical calculi; of course, necessarily, by the internal method, or passage of the remedy through the kidneys.

The internal method is applicable for the solution of *vesical* calculi, according to the observations referred to, only in cases of uric acid calculus; where also the stone is not large, and the urine is acid.

Two rules should be observed in applying this solvent treatment: to keep the urine *continuously* alkaline, and to maintain this state to a certain *degree.* A solution of bicarbonate of potash, less in strength than three grains to the pint of water, will have scarcely any greater effect than simple water.

The acetate and citrate of potash are the best salts for administration. Of the former, the dose for an adult should be from forty to sixty grains, in three or four ounces of water; for children, from twenty to thirty grains. The citrate is best prepared pure and of uniform strength from the crystallized bicarbonate of potash by the crystallized citric acid. Thus, the following prescription, recommended by Dr. Roberts, yields a solution containing one drachm of the citrate in each fluid ounce:

℞ Potass. Bicarb., ʒxij.
Acid. Citric, ʒviij, gr. xxiv.
Aquæ ad ℥xij.

The dose for an adult is six to eight drachms, mixed with three or four ounces of water; for children, three to six drachms, diluted in the same proportion.

To fulfil both the rules laid down, the dose must be repeated at intervals of not less than every three hours during the day, taking a dose the last thing before going to bed, and another, if the patient be awake, in the night.

In conducting this treatment, the freshly voided urine should be frequently examined. If, at any time, it becomes ammoniacal, as denoted by the odour and muco-purulent deposit, the solvent treatment must be suspended. So long as the urine remains free from ammoniacal taint, when passed, there will be no risk of any deposition of the mixed phosphates encrusting the stone.

Injection.—The other method of applying solvent agents is restricted chiefly to calculi which are soluble in acids,—phosphatic calculi. Alkalies, administered by injection, have very little effect on uric acid calculi; and acids pass through the kidneys only in very small proportions.

The injection method of treatment is, however, somewhat in this dilemma: that the solution, if strong enough to have any useful effect, may endanger the coats of the bladder; and if sufficiently diluted to avoid this danger, any solvent action on the stone is very uncertain.

A weak solution of nitric acid,—two, or two and a half minims of the strong acid to the ounce of distilled water,—was used by Sir B. Brodie, for the solution of phosphatic calculi by injection; and with the result of greatly reducing the size of the stone, or even at length accomplishing its entire dissolution. A weak solution of acetate of lead,—one grain to the ounce, with a mere trace of free acid, was the preparation and strength employed by Dr. Hoskins.

After *lithotrity,* injection may be used, as a solvent method of treatment, adjunctive to, or as a substitute for, the repeated operations of crushing fragments. The comparative merits of these two modes of procedure—the chemical solution, or mechanical crushing of stone in the bladder—must be determined by their relative speed and safety in effecting a cure. Good results have been obtained. Notably in a case by Mr. Southam, of Manchester. After repeated lithotrity, fresh phosphatic concretions continued to form in the bladder as fast as the old ones were crushed, so that the bladder could not be cleared. The mechanical operation having thus failed, an injection, containing two drachms of dilute nitric acid to a pint of water, was resorted to every day, or every second day. In the course of a short time, the old fragments were entirely dissolved, and the formation of new concretions prevented.

Injection may be performed through a double-current catheter, whereby a continuous stream of the solvent is made to act upon the stone.

(*b*) *Electrolysis,* or the dissolution of stone in the bladder by the transmission of an electric or galvanic current, has had its advocates. Sir W. B. O'Shaughnessy, Dr. Bence Jones, Dr. L. Melicher, and Gruithuisen, have severally attempted this method of treatment, but it is now abandoned.

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